SOIL SURVEY OF

Jasper County, Iowa

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Iowa Agriculture and Home Economics Experiment Station and the
Cooperative Extension Service
Iowa State University, and the
Department of Soil Conservation, State of Iowa

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1968–73. Soil names and descriptions were approved in 1974. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1974. This survey was made cooperatively by the Soil Conservation Service, the Iowa Agriculture and Home Economics Experiment Station and the Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Jasper County Soil Conservation District. Additional funds appropriated by Jasper County were used to defray part of the cost of this survey.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All of the soils of Jasper County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on Index to Map Sheets.

On each sheet of the detailed map soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the section "Crops and Pasture."

Foresters and others can refer to the section "Environmental Plantings" where the soils of the county are grouped according to their suitability for trees and shrubs.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife Habitat."

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and recreational areas in the sections "Engineering Uses of the Soils" and "Recreational Development."

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain estimates of soil properties and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Jasper County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "Environmental Factors Affecting Soil Use."

Cover: **Stripcropping, grassed waterways, and diversion terraces help to control erosion in an area of the Tama-Killduff-Muscatine association.**

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Issued March 1979

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SOIL SURVEY OF JASPER COUNTY, IOWA

By Lorne M. Nestrud and John R. Worster, Soil Conservation Service

Fieldwork by Lorne M. Nestrud, Arthur A. Bryant, Douglas B. Oelmann, James M. Clements, and Elmer H. Harvey, Soil Conservation Service [1]

United States Department of Agriculture, Soil Conservation Service, in cooperation with Iowa Agriculture and Home Economics Experiment Station and the Cooperative Extension Service, Iowa State University, and the Iowa Department of Soil Conservation, State of Iowa

JASPER COUNTY is in the central part of Iowa (fig. 1). The total area of the county is 467,840 acres. Newton is the county seat and is the largest town in the county. According to the 1970 census the population of Jasper County was 35,424, the population of Newton was 15,619, and the combined population of the other 11 towns or villages in the county was about 8,000.

Jasper County is mainly agricultural, and most of the acreage is in farms. The principal crops are corn, soybeans, oats, and hay. Much of the cropland is in corn, but the acreage of soybeans has greatly increased in recent years. The feeding of beef cattle and hogs is the most important livestock enterprise.

Bottom land makes up about 25 percent of the county. The rest is mainly rolling to strongly rolling soils on loess-covered uplands and steeper soils formed in glacial till on side slopes. The northwest corner of the county has the latest glacial drift and is generally level to gently rolling.

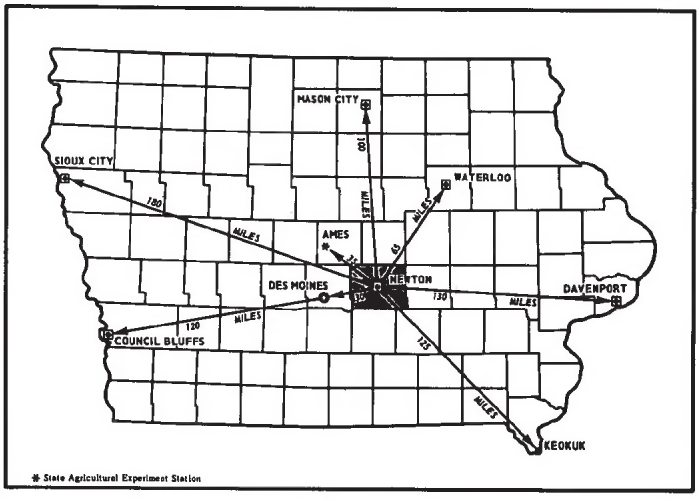

Figure 1.—Location of Jasper County in Iowa.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in Jasper County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and nature of streams, the kinds of native plants or crops, the kinds of rock and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of the plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The soil series and the soil phase are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Tama and Otley, for example, are the names of two soil series. All of the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Tama silty clay loam, 2 to 5 percent slopes, is one of several phases in the Tama series.

[1] Others who contributed to the survey were ELTON KING, DAVID MORRIS, and RODNEY POWERS, Soil Conservation Service.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units, soil complexes and undifferentiated groups, are shown on the soil map of Jasper County.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Shelby-Adair complex, 9 to 14 percent slopes, moderately eroded, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. If there are two or more dominant series represented in the group, the name of the group ordinarily consists of the names of the dominant soils, joined by "and." Caleb and Mystic soils, 9 to 14 percent slopes, moderately eroded, is an undifferentiated group in Jasper County.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Marsh is a land type in this survey.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants and as material, foundations, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or its high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General soil map

The general soil map at the back of this survey shows, in color, the soil associations in the survey area. A soil association is a landscape that has a distinctive pattern of soils in defined proportions. It typically consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in an association can occur in other associations, but in different patterns.

A map showing soil associations is useful to people who want to have a general idea of the soils in a survey area, who want to compare different parts of that area, or who want to locate large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide for broad planning on a watershed, a wooded tract, or a wildlife area or for broad planning of recreational facilities, community developments, and such engineering works as transportation corridors. It is not a suitable map for detailed planning for management of a farm or field or for selecting the exact location of a road or building or other structure, because the soils within an association ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

Soil associations and delineations on the general soil map in this soil survey do not always agree fully with general soil maps of adjacent counties published at a different date. Differences are brought about by better knowledge of soils and modifications or refinements in soil series concepts. In addition, the uses of the general soil map have expanded in recent years, thus requiring a more precise and detailed map to accommodate the need. Still another difference is caused by the range in slope of the soils within an association.

The soil associations in this survey area are described on the pages that follow.

1. Tama-Killduff-Muscatine association

Nearly level to moderately steep, well drained to somewhat poorly drained soils that formed in loess on uplands

This association consists of nearly level and gently

sloping soils on wide ridgetops and moderately sloping to moderately steep soils on side slopes (fig. 2).

This association occupies 26 percent of the county. It is about 40 percent Tama soils, 16 percent Killduff soils, 11 percent Muscatine soils, and 33 percent minor soils.

Tama soils are nearly level to strongly sloping and are on convex ridgetops and side slopes. These soils are well drained. They formed in loess under grass. The surface layer is very dark brown silty clay loam that is about 15 inches thick except where it is eroded. The subsoil is very dark grayish brown and brown silty clay loam. It is underlain by yellowish brown silty clay loam.

Killduff soils are moderately sloping to moderately steep. They are on convex side slopes near the heads of drainageways. These soils are moderately well drained. They formed in loess under grass. The surface layer is black silty clay loam about 7 inches thick. The subsoil is brown silty clay loam in the upper part and grades to yellowish brown and grayish brown mottled silty loam in the lower part.

Muscatine soils are nearly level and are on broad upland divides. They are somewhat poorly drained. These soils formed in loess under native grass. The surface layer is black silty clay loam about 18 inches thick. The subsoil is very dark grayish brown silty clay loam in the upper part and grades to dark grayish brown to grayish brown silty clay loam in the lower part.

Minor in this association are Colo, Ackmore, Garwin, and Downs soils. The somewhat poorly drained Ackmore soils and the poorly drained Colo soils are in drainageways. The poorly drained, nearly level Garwin soils are on plane or slightly concave upland divides. The well drained Downs soils are on ridgetops and side slopes.

Corn, soybeans, small grain, and hay are well suited to soils in this association. Artificial drainage is needed on some broad upland divides. Erosion is a hazard where the soils are sloping. Farming on the contour, stripcropping, terracing, and mulch tillage are effective in controlling erosion.

2. Downs-Tama-Shelby association

Nearly level to steep, well drained and moderately well drained soils that formed in loess and glacial till on uplands

This association consists of nearly level to moderately sloping soils on ridgetops and moderately sloping to steep soils on side slopes (fig. 3). The side slopes have many drainageways.

This association occupies about 39 percent of the county. It is about 21 percent Downs soils, 17 percent Tama soils, 10 percent Shelby soils, and 52 percent minor soils.

Downs soils are nearly level or gently sloping on convex ridgetops and moderately sloping to moderately steep on convex side slopes. These soils are well

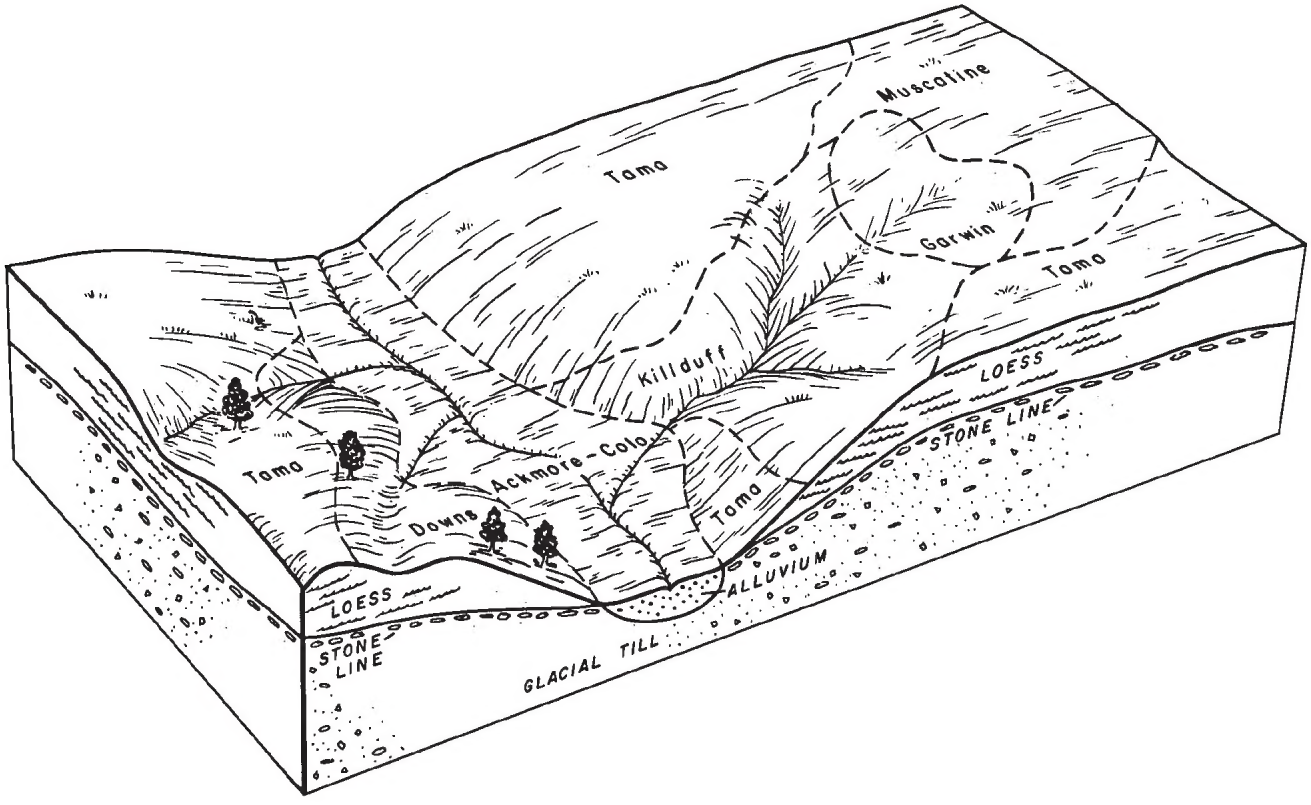

Figure 2.—**Relationship of slope and parent material to soils of the Tama-Killduff-Muscatine association.**

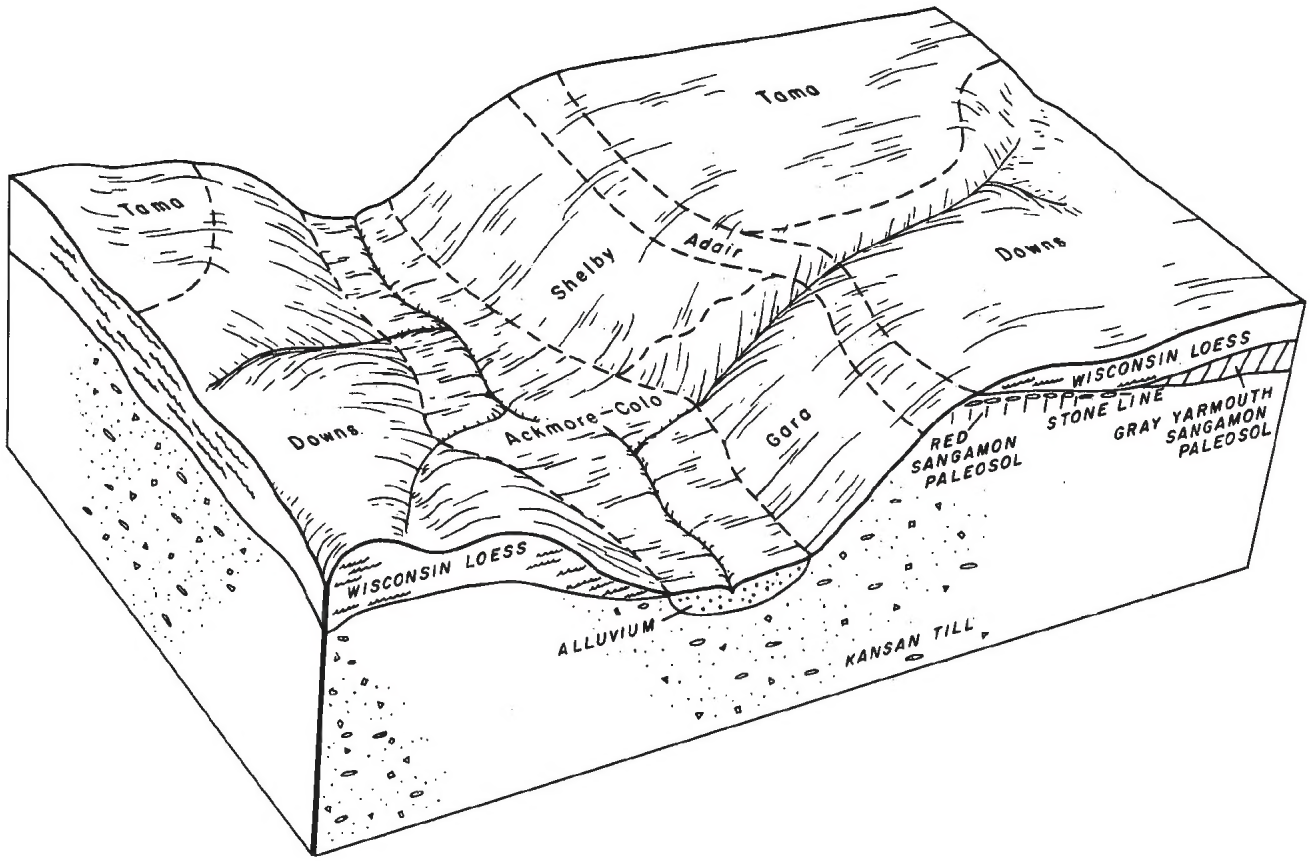

Figure 3.—**Relationship of soils and parent material in the Downs-Tama-Shelby association.**

drained. They formed in loess under deciduous trees and tall prairie grasses. The surface layer is very dark gray silt loam about 6 inches thick. The subsurface layer is dark grayish brown silt loam about 2 inches thick. The upper part of the subsoil is brown silty clay loam, and the lower part is yellowish brown silty clay loam and silt loam.

Tama soils are nearly level to strongly sloping and are on ridgetops and convex side slopes. These soils are well drained. They formed in loess under grass. The surface layer is very dark brown silty clay loam and is about 15 inches thick unless eroded. The subsoil is very dark grayish brown and brown silty clay loam.

Shelby soils are strongly sloping to steep and are on convex side slopes adjacent to drainageways. These soils are moderately well drained. They formed in glacial till under prairie grasses. The surface layer is black loam. The subsoil is dark brown clay loam in the upper part and grades to brown and yellowish brown clay loam in the lower part.

Minor in this association are Colo, Ackmore, Judson, Adair, Armstrong, Lamoni, Fayette, and Gara soils. The somewhat poorly drained Ackmore soils and poorly drained Colo soils are along upland drainageways. The moderately well drained Judson soils are on convex foot slopes. The well drained Fayette soils are on upper parts of side slopes along major drainageways. The moderately well drained to somewhat poorly drained Adair and Armstrong soils are on upper parts of side slopes that are downslope from Downs and Fayette soils. The somewhat poorly drained Lamoni soils are on side slopes at heads of drainageways. The well drained to moderately well drained Gara soils are on lower parts of side slopes.

Corn, soybeans, small grain, and hay are well suited to the nearly level to moderately sloping soils in this association. Permanent pasture and woodland are in the steep and very steep areas. Farming on the contour, stripcropping, terracing, and mulch tillage or minimum tillage used in combination on cropland are effective in controlling erosion.

3. Clarion-Lester association

Gently sloping to moderately steep, well drained soils that formed in glacial till on uplands

This soil association consists of gently sloping to moderately sloping soils. Some of the minor soils, however, are steep or very steep along larger drainageways (fig. 4).

This association occupies about 6 percent of the county. It is about 66 percent Clarion soils, 9 percent Lester soils, and 25 percent minor soils.

Clarion soils are gently sloping to moderately steep and are well drained. They formed in calcareous glacial till under tall prairie grasses. The surface layer is

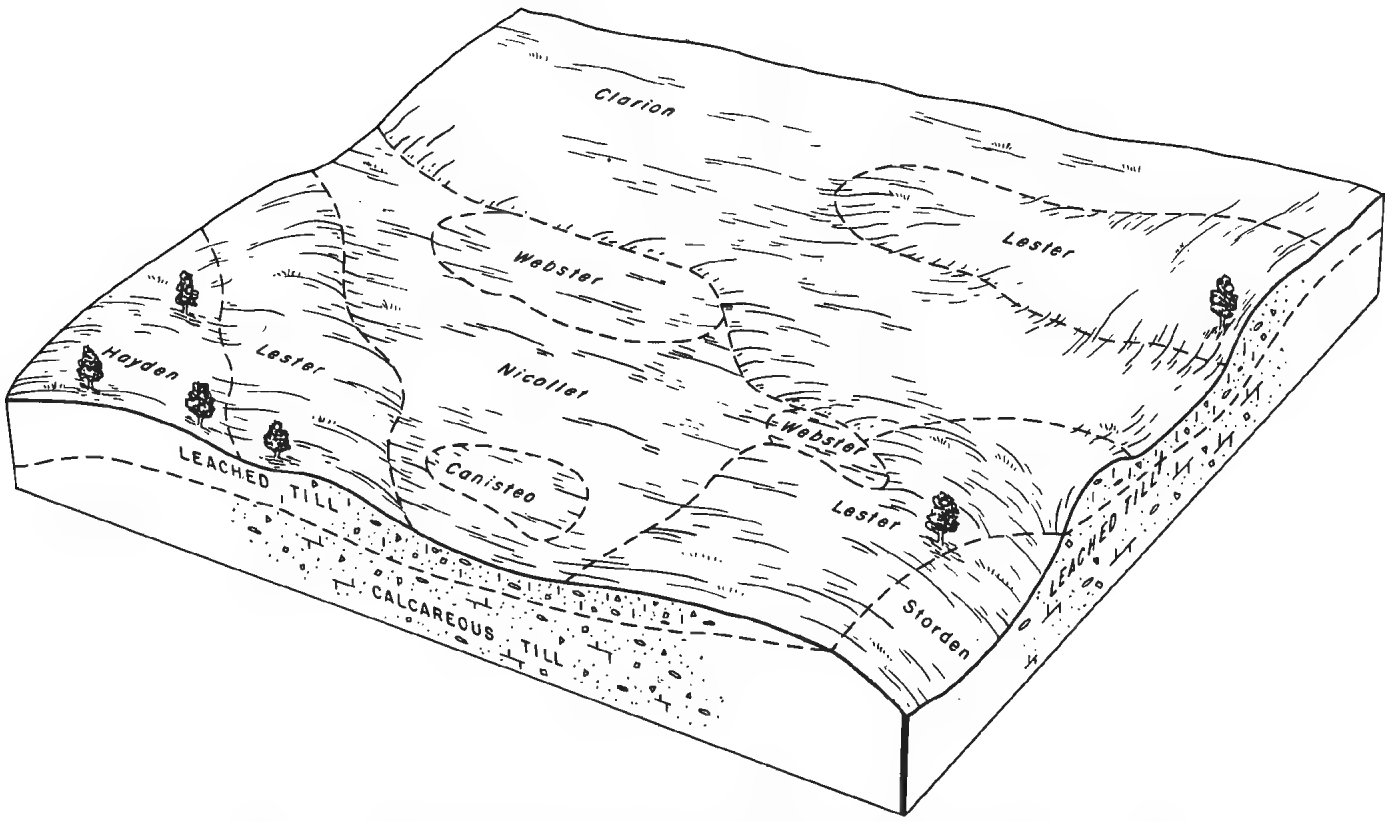

Figure 4.—**Relationship of slope and parent material to soils of the Clarion-Lester association.**

very dark brown loam about 12 inches thick. The subsoil is very dark brown loam in the upper part and brown loam in the lower part.

Lester soils are gently sloping to strongly sloping and are on convex ridgetops and side slopes adjacent to the major drainageways. These soils are well drained. They formed in calcareous glacial till under prairie grasses and trees. The surface layer is black and very dark grayish brown loam about 7 inches thick. The subsurface layer is dark grayish brown loam about 3 inches thick. The subsoil is brown and yellowish brown clay loam.

Minor in this association are Nicollet, Hayden, Webster, Storden, and Canisteo soils. The nearly level Nicollet soils are somewhat poorly drained. The moderately steep to very steep Hayden soils are well drained and are on convex side slopes adjacent to major drainageways. The calcareous, somewhat excessively drained Storden soils are moderately sloping to steep and are on convex side slopes. The poorly drained Webster and Canisteo soils are nearly level. They are on plane to concave upland positions and in heads of poorly defined drainageways.

Corn, soybeans, small grain, and hay are well suited to soils in this association. Hay, permanent pasture, and woodland are on the steep or very steep soils. Draining the wet soils and controlling erosion on the sloping soils are the main concerns of management. Most of the soils in this association respond well to fertilizer.

4. Nodaway-Zook-Nevin association

Level and nearly level, moderately well drained to poorly drained soils that formed in silty and clayey alluvium on bottom lands

This association is on bottom lands of the North and South Skunk Rivers, Indian Creek, and part of Elk Creek. They are on many of the old river channels and oxbows that have been drained, leveled, and cleared.

This association occupies 10 percent of the county. It is about 30 percent Nodaway soils, 25 percent Zook soils, 11 percent Nevin soils, and 34 percent minor soils (fig. 5).

Nodaway soils are nearly level and are adjacent to major streams and on alluvial fans. These soils are moderately well drained. The surface layer is very dark grayish brown and black silt loam about 9 inches thick. Below the surface layer is very dark grayish brown, dark grayish brown, and black stratified silt loam.

Zook soils are nearly level and are poorly drained. They are on low-lying parts of flood plains. The surface layer is black and is about 37 inches thick. It is silty clay loam in the upper part and silty clay in the lower part. The subsoil is black and very dark gray silty clay.

Nevin soils are nearly level and are somewhat poorly drained. They formed in silty alluvium on stream benches. The surface layer is silty clay loam about 22 inches thick. It is black in the upper part and grades

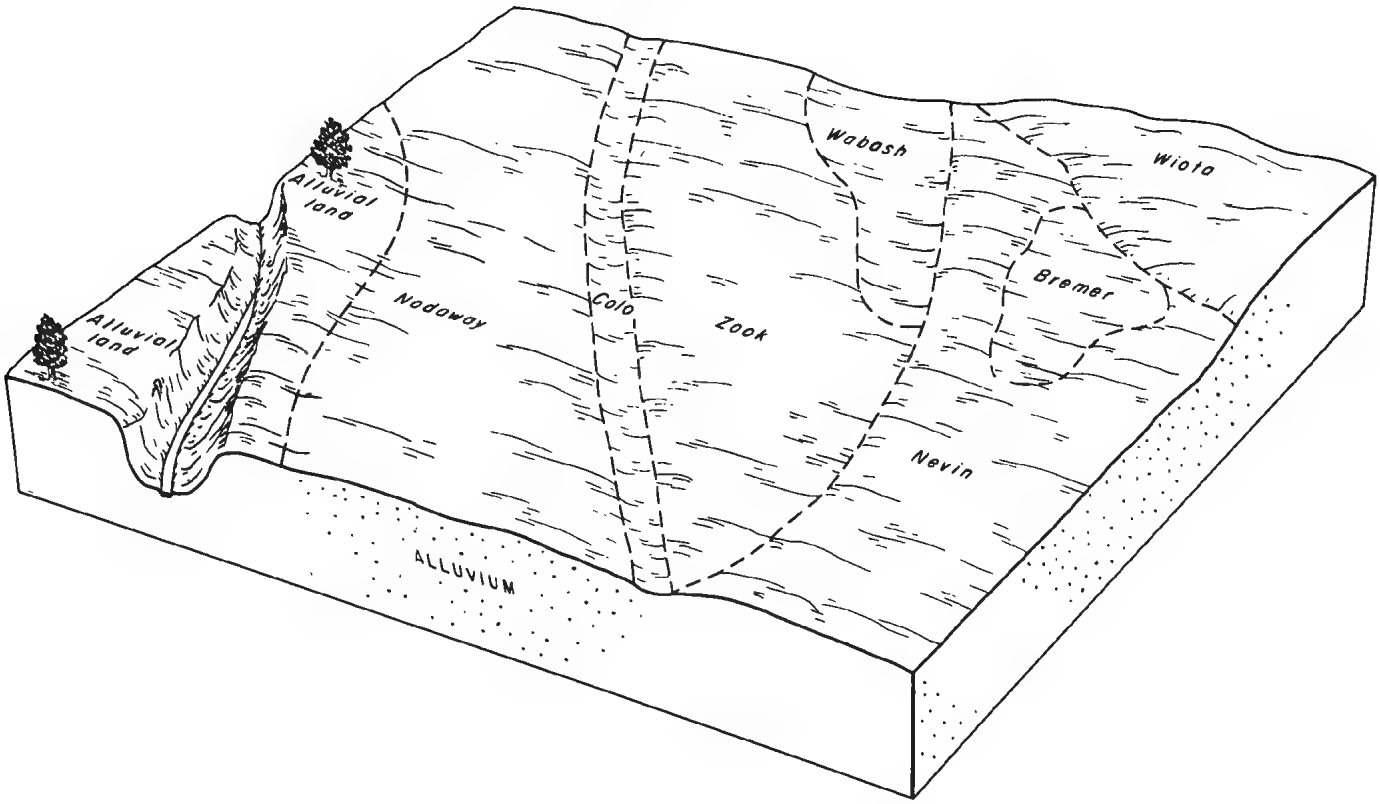

Figure 5.—**Relationship of slope and parent material to soils of the Nodaway-Zook-Nevin association.**

to very dark gray in the lower part. The subsoil is silty clay loam. It is dark grayish brown in the upper part and grades to grayish brown in the lower part.

Alluvial land is intermingled with the Nodaway soils near the stream channels. It consists of recently deposited stratified sediments and has a wide range of soil properties.

Minor in this association are Colo, Lawler, Wiota, Wabash, Ackmore, and Bremer soils. These nearly level soils are on bottom lands and stream benches. Colo, Wabash, and Bremer soils are poorly drained or very poorly drained silty clay loams or silty clays that have a thick, black surface layer. Lawler soils are somewhat poorly drained soils underlain by sand and gravel at a depth of about 2 or 3 feet. Wiota soils are well drained soils on the highest parts of stream benches. Ackmore soils are on the flood plain and are somewhat poorly drained. They formed in about 2 feet of recent stratified alluvium over a buried black silty clay loam.

These soils are used for cultivated crops. Corn, soybeans, and hay are commonly grown. Artificial drainage improves the suitability of many of these soils. On some soils, artificial drainage is essential for row crops. Tile systems do not function well on the fine-textured soils, so surface drains are used. Flooding is a major hazard for soils on the flood plains.

5. Otley-Mahaska association

Nearly level to strongly sloping, moderately well drained and somewhat poorly drained soils that formed in loess on uplands

This association consists of nearly level and gently sloping soils on wide ridgetops and moderately sloping and strongly sloping soils on side slopes.

This association occupies about 13 percent of the county. It is about 50 percent Otley soils, 10 percent Mahaska soils, and 40 percent minor soils (fig. 6).

Otley soils are gently sloping to strongly sloping and are on ridgetops and side slopes. These soils are moderately well drained. They formed in loess under grass. The surface layer is black in the upper part and very dark grayish brown in the lower part. It is silty clay loam about 18 inches thick, unless eroded. The subsoil is brown silty clay loam in the upper part and mottled yellowish brown and grayish brown silty clay loam in the lower part.

Mahaska soils are nearly level and are on upland divides. These soils are somewhat poorly drained. They formed in loess under grass. The surface layer is black silty clay loam about 22 inches thick. The upper part of the subsoil is dark grayish brown, and the lower part is grayish brown. The subsoil is silty clay loam.

Minor in this association are Nira, Adair, Lamoni, Shelby, Colo, Gara, Taintor, Sperry, and Ackmore soils. The gently to strongly sloping Nira soils are at the heads of waterways and on side slopes. Nira soils are moderately well drained. They formed in loess under grass. The surface layer is very dark gray silty clay loam about 8 inches thick, and the subsoil is mottled brown and grayish brown silty clay loam. The moderately well drained or somewhat poorly drained Adair and Lamoni soils are downslope from the ma-

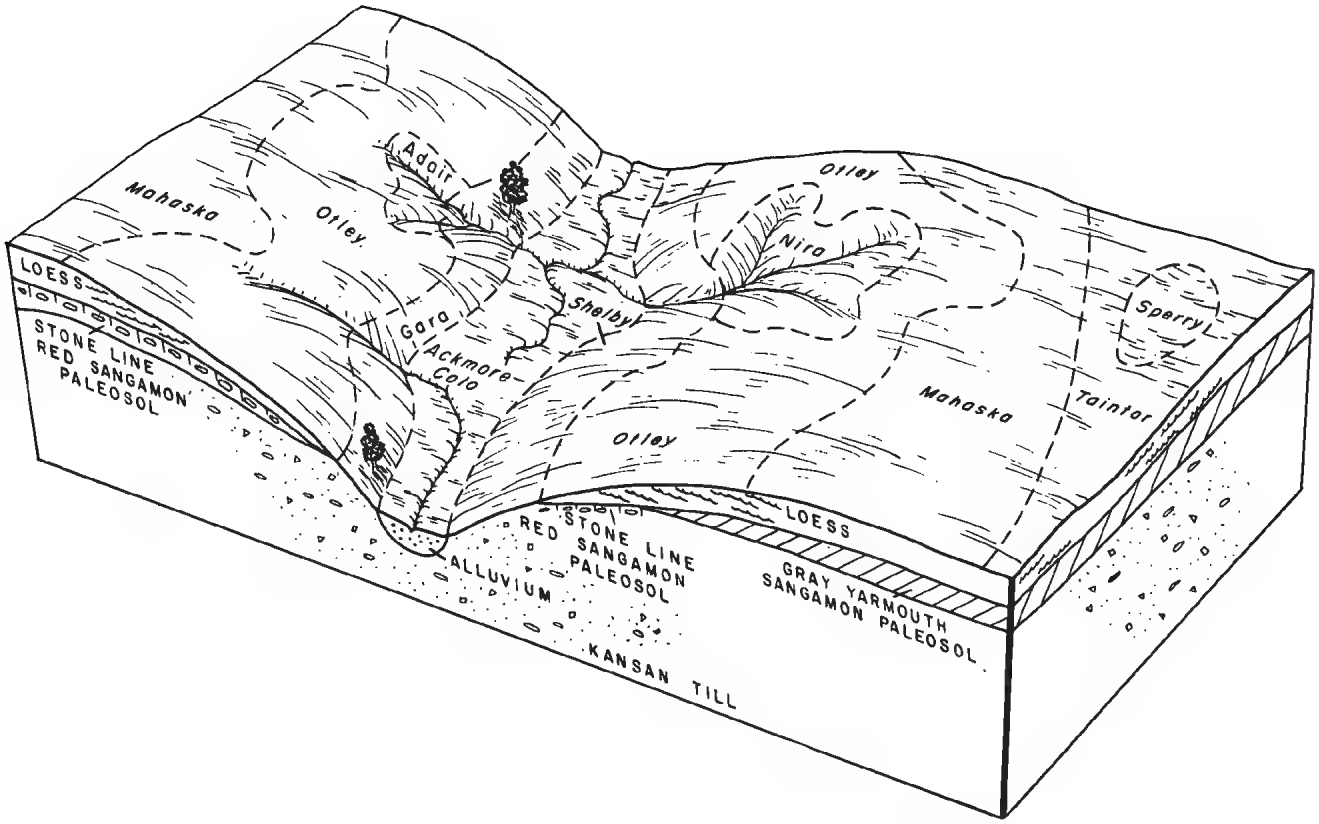

Figure 6.—**Relationship of slope and parent material to soils of the Otley-Mahaska association.**

jor soils. Well drained to moderately well drained Shelby and Gara soils are on the lower part of side slopes. Poorly drained Taintor soils are on divides, and poorly drained to very poorly drained Sperry soils are in small depressions on divides. The somewhat poorly drained Ackmore soils and the poorly drained Colo soils are on bottom lands.

Corn, soybeans, small grain, and hay are well suited to the soils in this association. The nearly level soils on upland divides and many of the soils on the bottom lands need artificial drainage. Erosion is a hazard on the sloping soils. Farming on the contour, stripcropping, terracing, and mulch tillage are effective in controlling erosion.

6. Ladoga-Gara association

Gently sloping to very steep, moderately well drained and well drained soils that formed in loess or glacial till on uplands

This association consists of gently sloping soils on convex ridgetops, and strongly sloping to very steep soils on side slopes that have many drainageways. These soils form a banded pattern around the heads and sides of major drainageways (fig. 7).

This association occupies about 4 percent of the county. It is about 35 percent Ladoga soils, 25 percent Gara soils, and 40 percent minor soils.

Ladoga soils are gently sloping and moderately sloping on convex ridgetops and moderately sloping and strongly sloping on convex side slopes in the uplands. These soils are moderately well drained. They formed in loess under deciduous trees and tall prairie grasses. The surface layer is very dark grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown and grayish brown silt loam about 5 inches thick. The subsoil is brown silty clay loam.

Gara soils are strongly sloping to very steep on convex side slopes in the uplands. These soils are moderately well drained to well drained. They formed in glacial till under a mixture of prairie grass and timber. The surface layer is very dark grayish brown loam 6 inches thick. The subsurface layer is dark grayish brown loam about 6 inches thick. The subsoil is yellowish brown clay loam.

Minor in this association are Clinton, Lindley, Armstrong, and Bauer soils. The moderately well drained Clinton soils are on rounded ridgetops and the upper parts of convex side slopes. The somewhat poorly drained to moderately well drained Armstrong soils are on the upper part of side slopes. The well drained to moderately well drained Lindley and Bauer soils are on the lower parts of side slopes.

Hay, permanent pasture, and woodland occupy a large part of this association. Erosion is a serious hazard on the sloping soils. Farming on the contour, stripcropping, terracing, and mulch tillage used in combination are effective in controlling erosion in areas that are under cultivation.

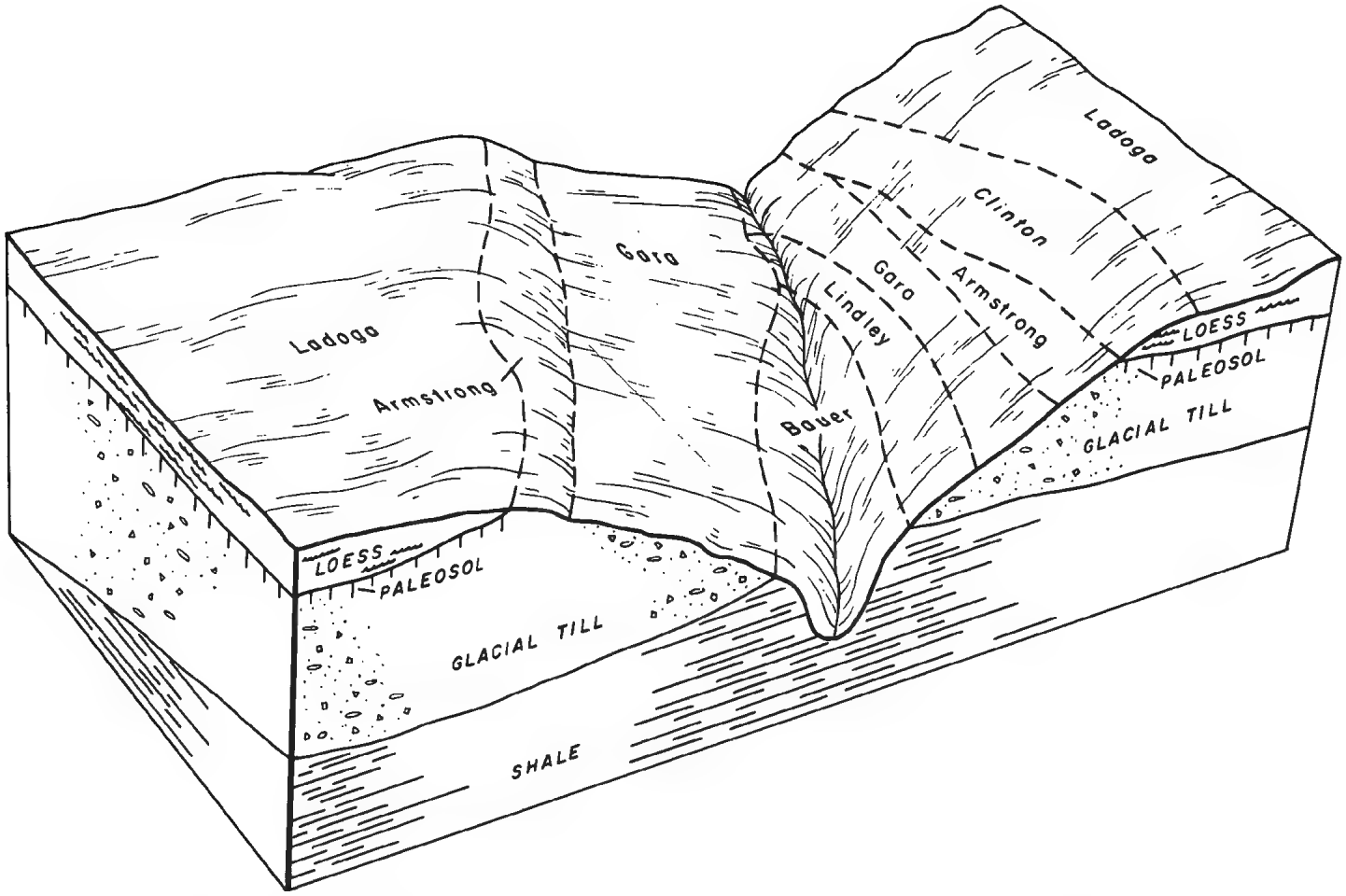

Figure 7.—**Relationship of slope and parent material to soils of the Ladoga-Gara association.**

7. Sparta-Chelsea-Dickinson association

Gently sloping to very steep, excessively drained to well drained soils that formed in sands on uplands and terraces

This association consists of soils in complex patterns on uplands and stream terraces in small areas adjacent to the South Skunk River.

This association occupies about 2 percent of the county. It is about 42 percent Sparta soils, 24 percent Chelsea soils, 14 percent Dickinson soils, and 20 percent minor soils.

Sparta soils are gently sloping on ridgetops and moderately sloping to moderately steep on side slopes. These soils are excessively drained. They formed in material deposited by wind or water under mixed grasses and forest. The surface layer is very dark brown loamy fine sand that grades to very dark grayish brown loamy sand; it is about 16 inches thick. The subsoil is brown and yellowish brown loamy sand.

Chelsea soils are gently sloping on ridgetops and steeper on side slopes. These soils are excessively drained. They formed in eolian sand under forest. The surface layer is very dark gray loamy fine sand about 3 inches thick. The subsurface layer is brown loamy fine sand and fine sand in the upper part and yellowish brown fine sand in the lower part.

Dickinson soils are gently sloping to strongly sloping and are well drained to somewhat excessively drained. They formed in moderately coarse textured material under prairie grasses. The surface layer is very dark brown and very dark grayish brown fine sandy loam about 13 inches thick. The subsoil is dark brown fine sandy loam in the upper part and brown loamy sand in the lower part.

Minor in this association are Port Byron, Downs, and Fayette soils. Well drained Port Byron soils are in a complex pattern with the major soils on side slopes. Well drained Downs and Fayette soils are in small isolated areas and are commonly upslope from the sandy soils.

Soils in this association are suited to grass and legumes for hay or permanent pasture. These soils are not heavily cultivated because of the steep slopes and droughtiness. Wildlife habitat and recreational areas could be developed on this association.

Descriptions of the soils

Each soil series is described in detail in this section and then each mapping unit in that series is described briefly. Unless stated otherwise, what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface down to rock or other underlying material. Each series contains two descriptions of the profile. The first is brief and in terms familiar to a layman. The second is more detailed and is included for those who need to make thorough and precise studies of soils. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit. Color terms are for moist soil unless otherwise stated.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Marsh, for example, does not belong to a soil series, but nevertheless it is listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is a symbol that identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit are the capability unit and the environmental planting group in which the mapping unit has been placed.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*14*).[2]

Ackmore series

The Ackmore series consists of somewhat poorly drained soils on flood plains and foot slopes. These soils formed in silty alluvium under a native vegetation of tall prairie grasses. Slopes are 0 to 5 percent.

In a representative profile the surface layer is very dark gray and very dark grayish brown silt loam about 15 inches thick. The underlying material is stratified black and very dark brown, friable silty clay loam to a depth of 25 inches. Beneath this, to a depth of 60 inches, is a buried soil. It is mostly black silty clay loam.

Permeability is moderately slow, and available water capacity is high. Available phosphorus is low in the subsoil, and available potassium is very low.

Ackmore soils are mainly used for cultivated crops. Flooding is a major hazard.

Representative profile of Ackmore silt loam, 0 to 2 percent slopes, in a cultivated field, 660 feet south and 250 feet west of the northeast corner of sec. 18, T. 81 N., R. 17 W.:

Ap—0 to 5 inches; very dark grayish brown (10YR 3/2) silt loam, dark gray (10YR 4/1) and dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; neutral; gradual smooth boundary.

A12—5 to 15 inches; stratified very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) silt loam, very dark grayish brown (10YR 3/2) crushed, grayish brown (10YR 5/2) dry; weak thin platy structure parting to weak fine granular; friable; slightly acid; gradual smooth boundary.

C—15 to 25 inches; black (10YR 2/1) and very dark brown (10YR 2/2) silty clay loam, very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) crushed, very dark gray (10YR 3/1) dry; thin strata of brown (10YR 5/3); weak thin platy structure parting to weak fine granular; friable; few fine distinct yellowish brown (10YR 5/8) mottles; medium acid; gradual smooth boundary.

IIA1b—25 to 36 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak very fine and fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

IIA12bg—36 to 43 inches; black (N 2/0) silty clay loam, black (10YR 2/1) crushed, very dark gray (10YR 3/1) and dark gray (10YR 4/1) dry; weak very fine and fine subangular blocky structure; slightly acid; clear wavy boundary.

IIB1bg—43 to 50 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) crushed, gray (10YR 5/1) and grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

IIB2bg—50 to 60 inches; black (10YR 2/1) and very dark gray (10YR 3/1) light silty clay loam, very dark gray (10YR 3/1) crushed, gray (10YR 5/1) and grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; neutral.

Typically, the buried soil is at a depth of 20 to 30 inches. The Ab horizon ranges from light silty clay loam to heavy silty clay loam.

Ackmore soils are near Colo, Nodaway, and Zook soils. Ackmore soils have a thinner deposit of stratified sediment over the buried soil than Nodaway soils. They have a thicker deposit than Colo and Zook soils.

430—Ackmore silt loam, 0 to 2 percent slopes. This soil is on first bottoms adjacent to streams and on alluvial fans. Areas are long and moderately wide. Many are parallel to the stream channel. They are about 10 to 100 acres or more in size.

This soil has the profile described as representative of the Ackmore series.

[2] Italic numbers in parentheses refer to References, p. 134.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Mapping unit	Acres	Percent
Ackmore silt loam, 0 to 2 percent slopes	10,270	2.2
Ackmore-Colo complex, 2 to 5 percent slopes	28,160	6.0
Ackmore-Colo complex, channeled, 2 to 5 percent slopes	4,640	1.0
Adair clay loam, 9 to 14 percent slopes, moderately eroded	1,885	.4
Alluvial land, channeled	9,420	2.0
Alluvial land-Nodaway complex, 0 to 2 percent slopes	3,295	.7
Armstrong loam, 9 to 14 percent slopes, moderately eroded	1,985	.4
Atterberry silt loam, 0 to 2 percent slopes	600	.2
Bauer silt loam, 9 to 18 percent slopes, moderately eroded	450	.1
Bauer silt loam, 18 to 40 percent slopes, moderately eroded	730	.2
Bolan loam, 0 to 2 percent slopes	310	.1
Bremer silty clay loam, 0 to 2 percent slopes	975	.2
Caleb and Mystic soils, 9 to 14 percent slopes, moderately eroded	415	.1
Caleb and Mystic soils, 14 to 18 percent slopes, moderately eroded	250	.1
Canisteo clay loam, 0 to 2 percent slopes	400	.1
Chelsea loamy fine sand, 4 to 9 percent slopes	805	.2
Chelsea loamy fine sand, 9 to 14 percent slopes	550	.1
Chelsea loamy fine sand, 14 to 25 percent slopes	540	.1
Chelsea-Fayette complex, 25 to 40 percent slopes	530	.1
Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded	665	.1
Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	520	.1
Clarion loam, 2 to 5 percent slopes	7,435	1.6
Clarion loam, 5 to 9 percent slopes, moderately eroded	5,180	1.1
Clarion loam, 9 to 14 percent slopes, moderately eroded	2,355	.5
Clarion loam, 14 to 18 percent slopes, moderately eroded	370	.1
Clinton silt loam, 5 to 9 percent slopes, moderately eroded	585	.1
Clinton silt loam, 9 to 14 percent slopes, moderately eroded	1,155	.3
Clinton silt loam, 14 to 18 percent slopes, moderately eroded	805	.2
Clinton soils, 9 to 14 percent slopes, severely eroded	255	.1
Coland clay loam, 0 to 2 percent slopes	1,415	.3
Coland clay loam, 2 to 5 percent slopes	945	.2
Colo silt loam, overwash, 0 to 2 percent slopes	3,295	.7
Colo silty clay loam, 0 to 2 percent slopes	9,090	1.9
Dickinson fine sandy loam, 2 to 5 percent slopes	535	.1
Dickinson fine sandy loam, 5 to 9 percent slopes	555	.1
Dickinson fine sandy loam, 9 to 14 percent slopes	240	.1
Downs silt loam, 0 to 2 percent slopes	240	.1
Downs silt loam, 2 to 5 percent slopes	5,180	1.1
Downs silt loam, 5 to 9 percent slopes, moderately eroded	11,370	2.4
Downs silt loam, 9 to 14 percent slopes, moderately eroded	19,615	4.2
Downs silt loam, 14 to 18 percent slopes, moderately eroded	4,410	.9
Downs silt loam, benches, 2 to 5 percent slopes	330	.1
Downs silt loam, benches, 5 to 9 percent slopes	210	(1)
Ely silty clay loam, 2 to 5 percent slopes	3,295	.7
Fayette silt loam, 2 to 5 percent slopes	495	0.1
Fayette silt loam, 5 to 9 percent slopes, moderately eroded	1,885	.4
Fayette silt loam, 9 to 14 percent slopes, moderately eroded	3,175	.7
Fayette silt loam, 14 to 18 percent slopes, moderately eroded	4,295	.9
Fayette silt loam, 18 to 25 percent slopes, moderately eroded	445	.1
Fayette soils, 9 to 14 percent slopes, severely eroded	370	.1
Flagler sandy loam, 1 to 4 percent slopes	690	.1
Gara loam, 9 to 14 percent slopes, moderately eroded	2,835	.6
Gara loam, 14 to 18 percent slopes, moderately eroded	6,170	1.3
Gara loam, 18 to 25 percent slopes, moderately eroded	2,450	.5
Gara loam, 25 to 40 percent slopes	440	.1
Gara-Armstrong loams, 9 to 14 percent slopes, moderately eroded	1,615	.4
Gara-Armstrong loams, 14 to 18 percent slopes, moderately eroded	8,950	1.9
Gara-Armstrong complex, 14 to 18 percent slopes, severely eroded	470	.1
Garwin silty clay loam, 0 to 2 percent slopes	1,615	.4
Garwin-Sperry complex, 0 to 2 percent slopes	710	.2
Hayden loam, 14 to 18 percent slopes, moderately eroded	625	.1
Hayden loam, 18 to 25 percent slopes	695	.2
Hayden loam, 25 to 40 percent slopes	570	.1
Judson silt loam, 0 to 2 percent slopes	895	.2
Judson silty clay loam, 2 to 5 percent slopes	5,455	1.2
Judson silty clay loam, 5 to 9 percent slopes	685	.1
Kennebec silt loam, 0 to 2 percent slopes	1,415	.3
Killduff silty clay loam, 5 to 9 percent slopes, moderately eroded	14,255	3.0
Killduff silty clay loam, 9 to 14 percent slopes, moderately eroded	12,590	2.7
Killduff silty clay loam, 14 to 18 percent slopes, moderately eroded	870	.2
Ladoga silt loam, 2 to 5 percent slopes	760	.2
Ladoga silt loam, 5 to 9 percent slopes, moderately eroded	2,385	.5
Ladoga silt loam, 9 to 14 percent slopes, moderately eroded	3,425	.7
Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded	3,495	.7
Lamoni silty clay loam, 14 to 18 percent slopes, moderately eroded	1,415	.3
Lawler loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	580	.1
Lawler loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	3,295	.7
Lester loam, 2 to 5 percent slopes	665	.1
Lester loam, 5 to 9 percent slopes, moderately eroded	970	.2
Lester loam, 9 to 14 percent slopes, moderately eroded	455	.1
Lindley loam, 14 to 18 percent slopes	5,650	1.2
Lindley loam, 18 to 25 percent slopes	2,740	.6
Lindley loam, 25 to 40 percent slopes	1,425	.3
Lindley soils, 14 to 18 percent slopes, severely eroded	2,030	.4
Mahaska silty clay loam, 0 to 2 percent slopes	6,595	1.4
Marsh	300	.1
Martinsburg silt loam, 2 to 5 percent slopes	600	.1
Martinsburg silt loam, 5 to 9 percent slopes	240	.1
Muscatine silty clay loam, 0 to 2 percent slopes	14,100	3.0

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

Mapping unit	Acres	Percent	Mapping unit	Acres	Percent
Nevin silty clay loam, 0 to 2 percent slopes	5,180	1.1	Shelby-Adair complex, 14 to 18 percent slopes, moderately eroded	4,710	1.0
Nicollet loam, 1 to 3 percent slopes	1,885	.4	Sparta loamy fine sand, 1 to 5 percent slopes	1,460	.3
Nira silty clay loam, 2 to 5 percent slopes, moderately eroded	290	.1	Sparta loamy fine sand, 5 to 9 percent slopes, moderately eroded	790	.2
Nira silty clay loam, 5 to 9 percent slopes, moderately eroded	1,415	.3	Sparta loamy fine sand, 9 to 18 percent slopes, moderately eroded	1,615	.4
Nira silty clay loam, 9 to 14 percent slopes, moderately eroded	2,830	.6	Sperry silt loam, 0 to 1 percent slopes	375	.1
Nodaway silt loam, 0 to 2 percent slopes	13,150	2.8	Storden loam, 5 to 14 percent slopes	550	.1
Olmitz loam, 2 to 5 percent slopes	1,415	.3	Storden loam, 14 to 18 percent slopes	345	.1
Olmitz loam, 5 to 9 percent slopes	425	.1	Storden loam, 18 to 25 percent slopes	195	(1)
Otley silty clay loam, 2 to 5 percent slopes	12,720	2.7	Taintor silty clay loam, 0 to 2 percent slopes	1,415	.3
Otley silty clay loam, 5 to 9 percent slopes, moderately eroded	12,245	2.6	Tama silty clay loam, 0 to 2 percent slopes	385	.1
Otley silty clay loam, 9 to 14 percent slopes, moderately eroded	5,650	1.2	Tama silty clay loam, 2 to 5 percent slopes	36,590	7.8
Port Byron silt loam, 5 to 9 percent slopes, moderately eroded	820	.2	Tama silty clay loam, 5 to 9 percent slopes, moderately eroded	26,605	5.7
Port Byron silt loam, 9 to 14 percent slopes, moderately eroded	2,085	.4	Tama silty clay loam, 9 to 14 percent slopes, moderately eroded	18,550	4.0
Port Byron silt loam, 14 to 18 percent slopes, moderately eroded	1,515	.3	Tama silty clay loam, benches, 2 to 5 percent slopes	885	.2
Port Byron silt loam, 18 to 25 percent slopes, moderately eroded	530	.1	Tama silty clay loam, benches, 5 to 9 percent slopes	470	.1
Shelby loam, 9 to 14 percent slopes, moderately eroded	2,930	.6	Terril loam, 2 to 5 percent slopes	990	.2
Shelby loam, 14 to 18 percent slopes, moderately eroded	7,065	1.5	Tuskeego silt loam, 0 to 1 percent slopes	845	.2
Shelby loam, 18 to 25 percent slopes, moderately eroded	1,985	.4	Wabash silty clay, 0 to 2 percent slopes	1,885	.4
Shelby-Adair complex, 9 to 14 percent slopes, moderately eroded	6,595	1.4	Webster silty clay loam, 0 to 2 percent slopes	860	.2
			Wiota silt loam, 0 to 2 percent slopes	2,455	.5
			Zook silty clay loam, 0 to 2 percent slopes	12,245	2.6
			Water	720	.2
			Quarries and sand pits	120	(1)
			Total	467,840	100.0

[1] Less than 0.05 percent.

Included with this soil in mapping are small areas of Nodaway, Zook, and Colo soils. Also included are small wet areas, which are indicated by a special symbol on the soil map.

This soil is well suited to row crops. Most areas are used for corn and soybeans. Some low-lying areas that are commonly flooded are in pasture or timber.

This soil is susceptible to flooding unless it is protected by dikes and levees. Some of the small depressional areas included in mapping are too wet for crops. The organic matter content is moderate. Capability unit IIw–2; environmental planting group 1.

5B—Ackmore-Colo complex, 2 to 5 percent slopes. This complex is in drainageways. Areas are narrow and long and are 10 to 30 acres or more in size. Typically, areas are about 50 percent Ackmore silt loam and about 35 percent Colo silty clay loam. The remaining 15 percent is mainly Ely and Judson soils. Ackmore soils are next to the channel or in areas that are most subject to flooding and siltation.

Included with this soil in mapping are some areas of Ackmore-Colo complex, channeled, 2 to 5 percent slopes.

This complex is well suited to cultivated crops. The included areas are better suited to pasture than to most other uses. This complex is generally farmed with soils of the adjacent uplands, and it is used and managed similarly to those adjacent soils.

This complex is subject to flooding by stream overflow and by the runoff from adjoining upland soils. Wetness, siltation, and rilling or gullying are hazards. Conservation practices that reduce runoff from the soils on the side slopes reduce these hazards. Grassed waterways are used in many areas. Organic matter content ranges from moderate to high. Capability unit IIw–1; environmental planting group 1.

C5B—Ackmore-Colo complex, channeled, 2 to 5 percent slopes. This complex is in areas adjacent to entrenched, meandering waterways. Individual areas are narrow and long. Typically, areas are about 50 percent Ackmore silt loam and 35 percent Colo silty clay loam. The remaining 15 percent is mainly Ely and Judson soils. The Ackmore soils are adjacent to the channels and in areas that are most subject to flooding and siltation.

Included with this soil in mapping are some areas of Ackmore-Colo complex, 2 to 5 percent slopes.

This complex is better suited to pasture than to other uses; areas are cut by the channels, and few are large enough for row crops to be feasible. The included areas are well suited to row crops.

This complex is subject to flooding by stream overflow and by the runoff from adjoining upland soils. Organic matter content ranges from moderate to high. Capability unit Vw–1; environmental planting group 1.

Adair series

The Adair series consists of moderately well drained or somewhat poorly drained soils that formed in moderately fine textured, reddish glacial till on the uplands. They formed under prairie grasses. Slopes are 9 to 18 percent.

In a representative profile the surface layer is very dark gray, very dark grayish brown, and dark brown clay loam about 10 inches thick. The firm clay loam subsoil is dark yellowish brown, brown, and yellowish red in the upper part and brown, strong brown, and grayish brown in the lower part. It is 50 inches thick. A line of small stones and gravel is common in the upper part of the subsoil. Mottles are also common in the subsoil.

Permeability is slow, and available water capacity is high. Available phosphorus in the subsoil is very low, and potassium is very low or low.

Adair soils are mainly used for hay and pasture, but some areas are planted to row crops. Erosion is the main hazard.

Representative profile of Adair clay loam, 9 to 14 percent slopes, moderately eroded, on an east-facing convex side slope in a bromegrass pasture, 78 feet east and 270 feet south of the northwest corner of SW¼ sec. 9, T. 80 N., R. 19 W.:

Ap—0 to 7 inches; very dark gray (10YR 3/1) light clay loam; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A3—7 to 10 inches; dark brown (10YR 3/3) and very dark grayish brown (10YR 3/2) clay loam; dark brown (10YR 3/3) kneaded; weak and moderate very fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B21—10 to 13 inches; dark yellowish brown (10YR 4/4) clay loam; weak fine subangular blocky structure; firm; pebbles and stones at base of horizon; slightly acid; clear smooth boundary.

IIB22t—13 to 22 inches; mottled brown (7.5YR 4/4) and yellowish red (5YR 4/6) heavy clay loam; moderate fine and medium subangular blocky structure; firm; thin discontinuous clay films; medium acid; clear smooth boundary.

IIB23t—22 to 48 inches; brown (7.5YR 4/4) heavy clay loam; common fine distinct light olive brown (2.5Y 5/6), grayish brown (2.5Y 5/2), and reddish brown (5Y 4/4) mottles; moderate medium angular and subangular blocky structure; firm; thin discontinuous clay films; medium acid; clear smooth boundary.

IIB3—48 to 60 inches; strong brown (7.5YR 5/6) and grayish brown (2.5Y 5/2 or 10YR 5/2) heavy clay loam; many fine distinct brown (7.5YR 4/4), red (2.5YR 4/6), and yellowish brown (10YR 5/8) mottles; massive; firm; neutral.

The thickness of the solum ranges from 40 to 65 inches. The A horizon is black (10YR 2/1), very dark gray (10YR 3/1), very dark brown (10YR 2/2), very dark grayish brown (10YR 3/2), or dark brown (10YR 3/3). In uneroded areas the A horizon is 10 to 17 inches thick. The texture of the A horizon commonly is clay loam, but the range includes silty clay loam, silt loam, and loam. The IIB2t horizon is medium acid or strongly acid. It is heavy clay loam or clay.

Adair soils lack the grayish mottles in the upper part of the B horizon that are typical of the series. Also, the dark brown color in the A3 horizon is not within the range defined for the series. These differences, however, do not have a significant effect on the use and behavior of the soils.

Adair soils are near and formed in materials similar to those of the Lamoni and Clarinda soils. Adair soils have redder hue in the B2 horizon than Lamoni and Clarinda soils.

192D2—Adair clay loam, 9 to 14 percent slopes, moderately eroded. This soil is in a narrow band, about 200 to 300 feet wide, on shoulders of convex side slopes. Areas range from 5 to 30 acres in size.

This soil has the profile described as representative of the series. In many areas, however, the dark brown and dark yellowish brown material from the lower part of the surface layer has been mixed with the upper part of the subsoil in the plow layer.

Included with this soil in mapping are a few small areas of moderately sloping Adair soils. Also included are some severely eroded spots, which are indicated by a special symbol on the soil map.

This soil usually is farmed with adjoining soils. It is suited to hay and pasture. Row crops can be grown occasionally. Because some of the subsoil is mixed in the plow layer in most places, it is hard to get a good seedbed. The subsoil is clayey and very low in organic matter. Erosion and runoff are the major hazards. Seepy, wet areas are common near areas where this soil comes in contact with loess soils upslope. Organic matter content is generally moderately low. Capability unit IVe–2; environmental planting group 1.

Alluvial land

C315—Alluvial land, channeled (0 to 2 percent slopes). This mapping unit consists of areas of alluvium recently deposited on first bottoms. This alluvial material varies widely in color and texture and is distinctly stratified. This mapping unit consists of light-colored silt and sand deposits with layers of dark-colored, clayey material.

Included in mapping are some areas of Nodaway, Colo, and Zook soils. Also included are some gently undulating areas.

This land is frequently flooded. It is subject to scouring and deposition each year when streams overflow. Much of this land is dissected by shallow meanders and oxbows. Some of the old stream channels are filled with water for long periods.

This alluvial land has limited value for cultivated crops unless it is cleared, smoothed, drained, and protected by dikes. Much of this land is wooded. It is suited to pasture in some areas and provides good habitat for wildlife. The supply of plant nutrients varies. The available water capacity is generally high. Capability unit Vw–1; environmental planting group 2.

315—Alluvial land-Nodaway complex, 0 to 2 percent slopes. This complex is on first bottoms along the major streams. Individual areas vary in size, but most are narrow and parallel the stream. Most areas are dissected by oxbows and meandering stream channels. This complex is about 70 percent alluvial land and 30 percent Nodaway silt loam. Typically, Nodaway silt loam is on the higher elevations in the individual areas. Alluvial land is variable in texture. Commonly it has a silty to sandy surface layer underlain by stratified mixtures ranging from sand to silty clay. Other properties also vary.

Most of this complex is in row crops, and it is moderately well suited to this use. Some areas are in woodland. Some areas are in pasture, many of which have scattered trees. Flooding is a serious hazard, and the oxbows and stream channels pond water, sometimes for long periods. If these hazards are overcome, this complex is well suited to row crops. Capability unit IIIw–1; environmental planting group 2.

Armstrong series

The Armstrong series consists of moderately well drained or somewhat poorly drained soils on uplands. These soils formed mostly in glacial till, but the upper part formed partly in loess or loess and erosional sediments. Native vegetation is grass and timber. Slopes are 9 to 18 percent.

In a representative profile the surface layer is very dark gray loam 6 inches thick. The subsurface layer is dark grayish brown loam 4 inches thick. The subsoil is 37 inches thick; it is brown, friable clay loam in the upper part and grades with depth to brown, firm clay and dark brown, strong brown, and yellowish brown, firm clay loam. Various colored mottles are in the subsoil. The substratum is mottled yellowish brown clay loam to a depth of 60 inches.

Permeability is slow, and available water capacity is high. Available phosphorus and potassium are very low in the subsoil.

Armstrong soils are used mainly for hay and pasture but are also planted to row crops. Erosion is the main hazard.

Representative profile of Armstrong loam, 9 to 14 percent slopes, moderately eroded, in an uneroded part of the unit, on an east-facing convex side slope in a permanent pasture, 80 feet west and 30 feet north of the southeast corner of SW¼SE¼ sec. 26, T. 81 N., R. 20 W.:

Ap—0 to 6 inches; very dark gray (10YR 3/1) loam; weak fine subangular blocky and granular structure; friable; neutral; clear smooth boundary.

A2—6 to 10 inches; dark grayish brown (10YR 4/2) loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak thin platy structure parting to weak fine subangular blocky; friable; slightly acid; gradual smooth boundary.

B1t—10 to 14 inches; brown (10YR 4/3) clay loam; few fine faint brown (10YR 5/3) mottles; weak and moderate fine subangular blocky structure; friable; thin discontinuous clay films; thin discontinuous light gray (10YR 7/1 dry) silt coats on faces of peds; slightly acid; gradual smooth boundary.

IIB21t—14 to 22 inches; brown (7.5YR 4/4) light clay; common fine distinct reddish brown (5YR 4/4), yellowish red (5YR 4/6), red (2.5YR 4/8), and grayish brown (10YR 5/2) mottles; moderate fine subangular blocky structure; firm; thin discontinuous silt coats; medium acid; gradual smooth boundary.

IIB22t—22 to 29 inches; brown (7.5YR 4/4) light clay; common fine distinct reddish brown (5YR 4/4), yellowish red (5YR 4/6), and red (10YR 4/8) mottles; few fine faint strong brown (7.5YR 5/6), brown (10YR 5/3), and grayish brown (10YR 5/2) mottles; moderate fine subangular blocky structure; firm; thin discontinuous clay films and silt coats on faces of peds; strongly acid; gradual smooth boundary.

IIB23t—29 to 38 inches; dark brown (7.5YR 4/4) and strong brown (7.5YR 5/6) heavy clay loam; few fine distinct yellowish red (5YR 4/6) mottles; weak medium prismatic structure parting to moderate fine subangular blocky; firm; thin discontinuous clay films and silt coats on faces of peds; medium acid; gradual smooth boundary.

IIB3t—38 to 47 inches, yellowish brown (10YR 5/6) heavy clay loam; few medium distinct dark brown (7.5YR 4/4), grayish brown (10YR 5/2), and light brownish gray (10YR 6/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; thin discontinuous clay films; medium acid; gradual smooth boundary.

IIC—47 to 60 inches; yellowish brown (10YR 5/4 and 5/6) clay loam; common medium distinct strong brown (7.5YR 5/8) and few medium faint grayish brown (10YR 5/2), light brownish gray (10YR 6/2), and brown (7.5YR 5/4) mottles; massive; firm; common dark accumulations; neutral.

The solum ranges from 42 to more than 60 inches in thickness. The A1 or Ap horizon is black (10YR 2/1), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). The texture is dominantly loam, but the range includes silt loam, silty clay loam, or clay loam. In cultivated or eroded areas, the A2 horizon is commonly mixed in the Ap horizon. The A2 horizon is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2) loam or silt loam. The IIB2t horizon is 36 to 48 percent clay. It is 12 to 30 inches thick. A band of pebbles is in many of the profiles. The part of the IIB2 horizon that has reddish matrix colors of 7.5YR hue or redder and mottles of 5YR hue or redder is 15 to 30 inches thick.

Armstrong soils are near and formed in similar materials as Gara and Lindley soils. Armstrong soils are upslope from Gara and Lindley soils. Armstrong

soils have reddish mottles of 5YR hue, which Gara and Lindley soils lack. Armstrong soils have more than 35 percent clay in the IIB2 horizon, and Gara and Lindley soils have 30 to 35 percent clay in the B2 horizon.

792D2—Armstrong loam, 9 to 14 percent slopes, moderately eroded. This soil is in a narrow band about 200 to 300 feet wide. It is on shoulders of convex side slopes. The size of the individual areas ranges from 10 to 20 acres.

This soil has a profile similar to the one described as representative for the series, but in most areas the subsurface layer and some of the subsoil are mixed in the plow layer.

Included with this soil in mapping are some areas of moderately steep Armstrong soils. Also included are some severely eroded areas about ½ to 3 acres in size. These areas are indicated by a special symbol on the soil map.

This soil is usually farmed with adjoining soils. It is suited to hay and pasture. Row crops can be grown occasionally, but it is hard to get a good seedbed. In most places some of the subsoil is mixed in the plow layer. The subsoil is clayey and very low in organic matter. Erosion is the major hazard. Seepy, wet areas are common near areas where this soil comes in contact with loess soils upslope. Organic matter content is generally low. Capability unit IVe–2; environmental planting group 1.

Atterberry series

The Atterberry series consists of somewhat poorly drained soils on divides in the uplands. These soils formed in loess under native vegetation of forest and prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is very dark gray silt loam about 6 inches thick. The subsurface layer is dark grayish brown light silty clay loam about 9 inches thick. The subsoil is 45 inches thick. It is dark grayish brown, friable silty clay loam in the upper part; mottled grayish brown and brown, friable silty clay loam in the middle part; and mottled grayish brown, yellowish brown, and strong brown, friable light silty clay loam in the lower part.

Permeability is moderate, and the available water capacity is high. Available phosphorus in the subsoil is low, and potassium is very low.

Atterberry soils are mainly used for cultivated crops. There are no serious hazards or limitations to use.

Representative profile of Atterberry silt loam, 0 to 2 percent slopes, in a pasture 570 feet east and 80 feet north of the southwest corner of the NE¼SE¼ sec. 19, T. 81 N., R. 20 W.:

A1—0 to 6 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine platy structure parting to weak fine granular; friable; slightly acid; gradual smooth boundary.

A2—6 to 15 inches; dark grayish brown (10YR 4/2) light silty clay loam, dark grayish brown (10YR 4/2) crushed, grayish brown (10YR 5/2) and light gray (10YR 6/1) dry; very dark grayish brown (10YR 3/2) coats on faces of peds; weak thin platy structure parting to moderate fine subangular blocky; friable; slightly acid; clear smooth boundary.

B1t—15 to 22 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine distinct light yellowish brown (10YR 6/4) mottles; moderate fine subangular and angular blocky structure; friable; thin discontinuous clay films and grayish brown (10YR 5/2) dry silt coats; slightly acid; clear smooth boundary.

B21t—22 to 32 inches; grayish brown (10YR 5/2) and brown (10YR 5/3) silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular and angular blocky structure; friable; dark grayish brown (10YR 4/2) coats on faces of peds; thin discontinuous clay films and silt coats; few dark colored accumulations of oxides; slightly acid; gradual smooth boundary.

B22t—32 to 44 inches; mottled grayish brown (10YR 5/2), brown (10YR 5/3), yellowish brown (10YR 5/6), and strong brown (7.5YR 5/6) light silty clay loam; weak medium prismatic structure parting to moderate medium subangular blocky; friable; thin continuous clay films and silt coats on faces of peds; few dark-colored accumulations of oxides; medium acid; gradual smooth boundary.

B3—44 to 60 inches, mottled grayish brown (10YR 5/2), yellowish brown (10YR 5/6), and strong brown (7.5YR 5/6) light silty clay loam; weak coarse prismatic structure; friable; thin discontinuous silt coats on faces of prisms; few dark-colored accumulations of oxides; medium acid.

The solum ranges from 40 inches to more than 60 inches in thickness. The A1 horizon is black (10YR 2/1), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). It is 4 to 8 inches thick. The A2 horizon ranges from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2). It is 4 to 9 inches thick.

Atterberry soils are associated with Downs and Muscatine soils, which also formed in loess. Atterberry soils have a thinner, lighter colored surface layer than Muscatine soils, and they have an A2 horizon, which Muscatine soils lack. Atterberry soils have a more grayish subsoil than Downs soils. Downs soils are better drained than Atterberry soils.

291—Atterberry silt loam, 0 to 2 percent slopes. This soil is on upland divides. Areas are long, wide, and irregular in shape.

Included with this soil in mapping are small areas of depressional soils that are poorly drained. These areas are indicated by special symbols on the soil map. Also included are some areas of soils that have a darker colored subsurface layer than Atterberry soils. These soils resemble Muscatine soils.

This Atterberry soil is well suited to row crops. It is

susceptible to slight wetness in some years. The organic matter content is moderate. Capability unit I–1; environmental planting group 1.

Bauer series

The Bauer series consists of well drained to moderately well drained soils on convex side slopes on uplands that generally border large stream valleys. These soils formed in silty or loamy sediments and in the underlying shale. Slopes are 9 to 40 percent.

In a representative profile the surface layer is black and very dark gray silt loam about 6 inches thick. The upper 15 inches of subsoil is dark grayish brown, grayish brown, and brown friable to firm silty clay loam, and the lower 8 inches is gray and grayish brown very firm clay. The upper part of the substratum is light brownish gray and light gray clay and clay loam. Below a depth of 53 inches, the substratum consists of thin strata of silty and sandy shale.

Permeability is very slow, and the available water capacity is moderate. The available phosphorus is very low, and the potassium is low in the subsoil.

Bauer soils are mainly used for pasture. Some areas are in timber, and a few areas are used for cultivated crops. Erosion is a serious hazard.

Representative profile of Bauer silt loam, 9 to 18 percent slopes, moderately eroded, in a bluegrass pasture, 500 feet south and 400 feet east of the northwest corner of SE¼NW¼ sec. 36, T. 78 N., R. 19 W.:

A11—0 to 4 inches; black (10YR 2/1) silt loam; weak very fine granular structure; very friable; slightly acid; gradual smooth boundary.

A12—4 to 6 inches; very dark gray (10YR 3/1) silt loam; weak thin platy structure parting to very fine granular; very friable; medium acid; clear smooth boundary.

B1—6 to 10 inches; dark grayish brown (10YR 4/2) silty clay loam; weak very fine and fine subangular blocky structure; friable; very dark grayish brown (10YR 3/2) coats and thin discontinuous silt coats and clay films on faces of peds; medium acid; clear smooth boundary.

B21—10 to 13 inches; dark grayish brown (10YR 4/2), grayish brown (10YR 5/2), and brown (10YR 5/3) silty clay loam; many fine distinct olive yellow (2.5Y 6/6) mottles; moderate fine subangular and angular blocky structure; friable; thin discontinuous silt coats and clay films on faces of peds; medium acid; abrupt smooth boundary.

IIB22—13 to 21 inches; grayish brown (10YR 5/2) and brown (10YR 5/3) heavy silty clay loam; many fine distinct olive yellow (2.5Y 6/6) mottles; moderate medium angular blocky structure; firm; thin discontinuous silt coats and clay films on faces of peds; medium acid; gradual smooth boundary.

IIB23—21 to 29 inches; gray (10YR 5/1) and grayish brown (10YR 5/2) clay; many medium distinct brownish yellow (10YR 6/6) and yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure; very firm; slightly acid; gradual smooth boundary.

IIC1—29 to 37 inches; light brownish gray (2.5Y 6/2) clay; many medium distinct brownish yellow (10YR 6/6) mottles; thick platy rock structure; firm; few calcium carbonate concretions; neutral; gradual smooth boundary.

IIC2—37 to 53 inches; light gray (2.5Y 7/2) and light brownish gray (2.5Y 6/2) light clay loam; many moderate distinct brownish yellow (10YR 6/6) mottles; thick platy rock structure; firm; few calcium carbonate concretions; neutral; gradual smooth boundary.

IIC3—53 to 60 inches; light yellowish brown (2.5Y 6/4) stratified loam, sandy loam, loamy sand, and clay; many medium distinct yellowish brown (10YR 5/6) mottles; medium platy rock structure; friable to firm; neutral.

The A horizon is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2) loam or silt loam. It is 8 to 15 inches thick except where eroded. The B2 horizon is yellowish brown (10YR 5/4) or brown (10YR 4/3) silty clay loam or clay loam in places.

Many eroded areas have a thinner A horizon than is defined for the series, but this does not have a significant effect on the use of the soils. Typically the Bauer soils in this county have calcium carbonate concretions above a depth of 40 inches, which is not within the defined range of the series. This does not significantly affect the use or behavior of the soils.

Bauer soils are near Tama and Otley soils, which formed in loess, and Gara and Shelby soils, which formed in glacial till. Bauer soils are downslope from these soils.

185E2—Bauer silt loam, 9 to 18 percent slopes, moderately eroded. This soil is on convex side slopes that border drainageways. Typically, the areas are narrow bands at the base of slopes and are 5 to 25 acres in size.

This soil has the profile described as representative of the series. In many places where the soil is plowed, some of the dark grayish brown subsoil is mixed into the plow layer.

Included with this soil in mapping are areas of severely eroded soils and coal mine spoil banks. These areas are shown by special symbols on the soil map. Gullies are common in many areas.

This soil is suited to permanent pasture and wildlife habitat. It is very susceptible to excessive runoff and is highly erodible. Organic matter content is generally low. Capability unit VIe–2; environmental planting group 1.

185F2—Bauer silt loam, 18 to 40 percent slopes, moderately eroded. This soil is on convex side slopes. Typically, these areas are in narrow bands at the bases of slopes. These areas range from 10 to 25 acres in size.

This soil has a profile similar to the one described as

representative of the series, but the surface layer is thinner and depth to shale is only 10 to 14 inches. The surface layer is very dark grayish brown in areas where this soil has been plowed, and some of the dark grayish brown subsoil is mixed into the plow layer.

Included with this soil in mapping are areas of severely eroded soils, coal mine dumps, and spoil areas. These are shown by special symbols on the soil map.

This soil is suited to permanent pasture and wildlife habitat. It is very susceptible to erosion and has a high rate of runoff because of its steep and very steep slopes and very slow permeability. Organic matter content is generally low. Capability unit VIIe–1; environmental planting group 1.

Bolan series

The Bolan series consists of well drained soils on stream benches. These soils formed in loamy alluvial sediments reworked by wind. Native vegetation was prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is loam; the upper 14 inches is black, and the lower 3 inches is very dark grayish brown. The subsoil is dark brown and dark yellowish brown, friable loam in the upper 11 inches and dark yellowish brown, very friable fine sandy loam in the lower 10 inches. The substratum is dark yellowish brown loamy fine sand.

Permeability is moderate in the upper part of the profile and rapid in the lower part. Available water capacity is moderate. Available phosphorus is low in the subsoil, and available potassium is very low.

Bolan soils generally are used for cultivated crops. The major hazards are drought and soil blowing. Fertility is generally low.

Representative profile of Bolan loam, 0 to 2 percent slopes, on a stream bench, 300 feet west and 330 feet south of the center of sec. 10, T. 79, N., R. 21 W.:

Ap—0 to 6 inches; black (10YR 2/1) loam; weak fine granular structure; very friable; slightly acid; gradual smooth boundary.

A12—6 to 14 inches; black (10YR 2/1) loam; weak fine granular structure; very friable; slightly acid; gradual smooth boundary.

A13—14 to 17 inches; very dark grayish brown (10YR 3/2) loam; weak fine granular structure; very friable; neutral; gradual smooth boundary.

B1—17 to 28 inches; dark brown (10YR 3/3) and dark yellowish brown (10YR 3/4) loam; very dark grayish brown (10YR 3/2) coats on faces of peds; weak coarse subangular blocky structure; very friable; slightly acid; gradual smooth boundary.

B2—28 to 38 inches; dark yellowish brown (10YR 4/4) fine sandy loam; weak coarse subangular blocky structure; very friable; slightly acid; gradual smooth boundary.

IIC—38 to 60 inches; dark yellowish brown (10YR 4/4) loamy fine sand; single grained; loose; slightly acid.

The solum typically ranges from 30 to 48 inches in thickness. Carbonates and pebbles are typically absent from the solum. The 10 to 40 inch control section averages from 14 to 18 percent clay. The A1 horizon is typically black (10YR 2/1) and ranges to very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). The A1 horizon is loam or silt loam that is high in sand content. It is 10 to 17 inches thick. The B2 horizon ranges from dark yellowish brown (10YR 3/4) to yellowish brown (10YR 5/6) loam or fine sandy loam. The IIC horizon is mainly loamy fine sand but includes some fine and medium sand.

Bolan soils are near Lawler and Coland soils. Bolan soils are well drained, whereas Coland soils are poorly drained and Lawler soils are somewhat poorly drained.

174—Bolan loam, 0 to 2 percent slopes. This soil is on stream benches. Typical areas are moderately wide and are irregular in shape. Included with this soil in mapping are small knolls that are sandy and excessively drained and swales that are somewhat poorly drained to poorly drained. The poorly drained areas are indicated by a special symbol on the soil map.

This soil is commonly used for row crops. Droughtiness is the main hazard. It is also susceptible to soil blowing. Organic matter content is moderate. Capability unit IIs–1; environmental planting group 1.

Bremer series

The Bremer series consists of poorly drained soils that formed in moderately fine textured alluvium on low benches or high second bottoms. Native vegetation was prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black silty clay loam 17 inches thick. The subsoil is firm silty clay loam. It is very dark gray in the upper part and dark gray in the lower part, to a depth of 62 inches.

Permeability is slow to moderately slow, and available water capacity is high. Available phosphorus and potassium are low in the subsoil.

Bremer soils are commonly used for corn and soybeans. Wetness is the major hazard. Flooding is a hazard at the lower elevations.

Representative profile of Bremer silty clay loam, 0 to 2 percent slopes, 600 feet south and 400 feet east of the northwest corner of sec. 19, T. 79 N., R. 19 W.:

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A12—8 to 17 inches; black (10YR 2/1) silty clay loam; weak very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B21t—17 to 24 inches; very dark gray (10YR 3/1) heavy silty clay loam; moderate fine subangular blocky structure; firm; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B22tg—24 to 34 inches; very dark gray (10YR 3/1) heavy silty clay loam; few fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; moderate fine subangular blocky structure; firm; thin discontinuous clay films and silt coats; slightly acid; gradual smooth boundary.

B31tg—34 to 46 inches; dark gray (5Y 4/1)

heavy silty clay loam; very dark gray (5Y 3/1) coats on peds; many medium distinct olive (5Y 5/4) and yellowish brown (10YR 5/4 and 5/6) mottles; weak fine subangular blocky structure; firm; thin discontinuous clay films and silt coats; few fine dark concretions; slightly acid; gradual smooth boundary.

B32tg—46 to 62 inches; dark gray (5Y 4/1) heavy silty clay loam; many medium faint light olive brown (2.5Y 5/4) and few fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; weak angular blocky structure, massive in lower part; firm; thin discontinuous clay films and silt coats on tongues; few fine dark concretions; slightly acid.

The solum ranges from 40 inches to more than 60 inches in thickness. The depth to carbonates is 60 inches or more. The A horizon is black (10YR 2/1) or very dark gray (N 3/0). It is 14 to 20 inches thick. The B2t horizon is 36 to 44 percent clay and is 14 to 22 inches thick. The few fine faint mottles in the B2 horizon increase in size and abundance with depth. In places the C horizon is stratified and medium textured.

Dark colors extend to a depth of about 34 inches, which is deeper than the normal range for the Bremer series. This does not have a significant effect on the use and behavior of the soils.

Bremer soils are near Colo, Wabash, and Zook soils. These soils have profiles that are somewhat similar to those of Bremer soils. Bremer soils typically are higher on the landscape than these soils and are more strongly developed, as evidenced by the accumulation of clay in the B horizon.

43—Bremer silty clay loam, 0 to 2 percent slopes. This soil is on low stream benches or high second bottom lands. Areas are fairly large, and some are over 120 acres. In some areas where flooding occurs, recent deposits of sediments are on the surface.

Included with this soil in mapping are areas of Wabash soils in small depressions and narrow swales. Areas of these very poorly drained soils are indicated by special symbols on the soil map.

This soil is suited to corn, soybeans, small grains, and hay. Wetness is the major limitation. This soil dries slowly. If the soil is worked when it is too wet, it becomes puddled and cloddy and a good seedbed is difficult to establish. Maintaining good tilth is a problem even if the drainage is improved. Some areas are subject to flooding. Organic matter content is high. Capability unit IIw–2; environmental planting group 2.

Caleb series

The Caleb series consists of moderately well drained soils on short, rounded side slopes at the lower part of the steeper uplands and high benches along major streams. These soils formed in water-sorted glacial sediments. Native vegetation was mixed grass and forest. Slopes are 9 to 18 percent.

In a representative profile the plow layer is very dark grayish brown loam about 6 inches thick. The subsurface layer is brown loam about 3 inches thick. The subsoil extends to a depth of 60 inches or more. It is brown and yellowish brown, firm clay loam in the upper part and yellowish brown, friable sandy clay loam in the lower part.

Permeability is moderate to moderately slow. In places the substratum has moderately rapid permeability because of the sandier texture. Available water capacity is moderate. Available phosphorus and potassium are very low in the subsoil.

Caleb soils are mainly used for hay and pasture, but cultivated crops are also grown. Erosion is the major hazard.

Representative profile of an uneroded Caleb soil in an area of Caleb and Mystic soils, 9 to 14 percent slopes, moderately eroded, on a southwest-facing slope in an alfalfa field, 250 feet west and 250 feet south of the northeast corner of the SW¼NW¼ sec. 36, T. 80 N., R. 17 W.:

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) loam; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A2—6 to 9 inches; brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; discontinuous silt coats on faces of peds; neutral; clear smooth boundary.

B1—9 to 12 inches; brown (10YR 4/3) light clay loam; moderate fine and medium subangular blocky structure; firm; few fine dark-colored accumulations of oxides; discontinuous silt coats on faces of peds; neutral; clear smooth boundary.

B21t—12 to 17 inches; brown (10YR 4/3) clay loam, brown (10YR 5/3) kneaded; strong medium subangular blocky structure; firm; few fine dark-colored accumulations of oxides; discontinuous silt coats on faces of peds; neutral; clear smooth boundary.

B22t—17 to 24 inches; yellowish brown (10YR 5/4) clay loam; strong medium subangular blocky structure; firm; thin discontinuous clay films and silt coats on vertical faces; few fine dark reddish brown (5YR 2/2) accumulations of oxides; neutral; gradual smooth boundary.

B23t—24 to 31 inches; yellowish brown (10YR 5/4) clay loam; strong fine prismatic and medium subangular blocky structure; firm; thin discontinuous clay films and light gray (10YR 7/2) silt coats on the faces of peds; few fine distinct dark reddish brown (5YR 2/2) accumulations of oxides; slightly acid; gradual smooth boundary.

B24t—31 to 36 inches; yellowish brown (10YR 5/4) clay loam; strong fine prismatic and medium subangular blocky structure; firm; thin discontinuous clay films and light gray (10YR 7/2) silt coats on the faces of peds; slightly acid; gradual smooth boundary.

B31—36 to 48 inches; yellowish brown (10YR 5/4) sandy clay loam; few fine faint strong brown (7.5YR 5/6) mottles;

weak coarse prismatic structure; friable; few fine distinct dark reddish brown (5YR 2/2) accumulations of oxides; thin discontinuous clay films and light gray (10YR 7/2) silt coats on faces of peds; slightly acid; gradual smooth boundary.

B32—48 to 64 inches; yellowish brown (10YR 5/4) sandy clay loam; few fine faint strong brown (7.5YR 5/6) and grayish brown (10YR 5/2) mottles; weak coarse prismatic structure; friable; thin discontinuous clay films and light gray (10YR 7/2) silt coats on faces of peds; slightly acid; gradual smooth boundary.

The solum is 5 or more feet thick, and carbonates are absent to below that depth. It ranges from neutral to strongly acid. The A1 or Ap horizon is loam, silt loam, or light clay loam and is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The A2 horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3) loam, silt loam, or light clay loam. In many places the A2 horizon is mixed with the Ap horizon. The B3 and C horizons observed range from sandy loam to sandy clay loam and contain strata of coarse material in places.

Caleb soils are mapped in complexes with Mystic soils. They occur downslope from Shelby and Gara soils. All of these soils formed in till or till-derived material. Caleb soils have a coarser textured B2t horizon than Mystic soils and lack the reddish color typical of Mystic soils. Caleb soils have more sand in the profile and are more stratified than Shelby and Gara soils.

94D2—Caleb and Mystic soils, 9 to 14 percent slopes, moderately eroded. Areas of this group are on the lower part of side slopes on uplands or on remnants of high benches. Areas are commonly less than 15 acres in size. This group is about 55 percent Caleb soils and about 45 percent Mystic soils. The Mystic soils are along the upper edge of individual areas, and the Caleb soils are downslope. Where the soils have been plowed, the brown subsurface layer and upper part of the subsoil have been mixed into the plow layer. The Mystic soils in this unit have a profile similar to the one described as representative of that series, but more subsoil material is mixed into the plow layer.

These soils are usually farmed with adjoining soils. They are well suited to hay and pasture, but row crops can be grown occasionally. Erosion is the major hazard. Maintaining good tilth is a problem that is made more difficult by the loss of organic matter by erosion and the mixing of the clayey subsoil into the plow layer. Organic matter content is generally low. Capability unit IVe–2; environmental planting group 1.

94E2—Caleb and Mystic soils, 14 to 18 percent slopes, moderately eroded. Areas of this group are on the lower part of convex side slopes or on remnants of high benches. This unit is about 50 percent Caleb soils and 50 percent Mystic soils. Caleb soils are downslope from the Mystic soils. Areas are generally 5 to 10 acres in size. The Caleb soils have a profile similar to the one described as representative of the Caleb series. In most places that have been plowed, the brown subsurface layer and the upper part of the subsoil have been mixed into the plow layer. The Mystic soils in this complex have a profile similar to the one described as representative of the series, but in places a considerable amount of subsoil material has been mixed into the plow layer.

Most areas of this unit are in pasture. These soils are poorly suited to cultivated crops. They can be planted to corn occasionally as the first step in renovating pasture, but erosion is a serious hazard. Tilth usually is poor because of the low organic matter content and the mixing of subsoil material into the plow layer. Capability unit VIe–2; environmental planting group 1.

Canisteo series

The Canisteo series consists of poorly drained, calcareous soils in plane or slightly depressional positions. These soils formed in loamy glacial sediments on uplands. Native vegetation was tall grasses and sedges. Slope is 0 to 2 percent.

In a representative profile the surface layer is calcareous clay loam about 21 inches thick; the upper part is black, and the lower few inches is very dark gray. The subsoil is dark gray and olive gray, calcareous loam to a depth of 36 inches. The substratum is mottled olive gray, calcareous loam.

Permeability is moderate, and available water capacity is high. Available phosphorus and potassium are very low in the subsoil.

The Canisteo soils are used primarily for row crops. Wetness is the major hazard.

Representative profile of Canisteo clay loam, 0 to 2 percent slopes, in a slightly concave depression in soybean stubble, 600 feet east and 240 feet south of northwest corner of NE¼ sec. 8, T. 81 N., R. 21 W.:

Ap—0 to 10 inches; black (N 2/0) clay loam; weak fine granular structure; friable; slight effervescence; mildly alkaline; gradual smooth boundary.

A12—10 to 17 inches; black (N 2/0) light clay loam; weak fine granular structure; friable; slight effervescence; mildly alkaline; clear wavy boundary.

A3g—17 to 21 inches; very dark gray (10YR 3/1) light clay loam; weak medium and fine subangular blocky structure; friable; slight effervescence; mildly alkaline; clear wavy boundary.

B21g—21 to 29 inches; dark gray (5Y 4/1) heavy loam; few fine prominent yellowish brown (10YR 5/6) mottles; weak medium and fine subangular blocky structure; friable; strong effervescence; many accumulations and concretions of carbonates; moderately alkaline; clear wavy boundary.

B22g—29 to 36 inches; olive gray (5Y 4/2) loam; dark gray (5Y 4/1) coats on faces of peds; few fine prominent yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; friable; strong effervescence; few accumulations and

concretions of carbonates; moderately alkaline; clear wavy boundary.

C1g—36 to 43 inches; olive gray (5Y 5/2) loam; common fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; violent effervescence; few accumulations and concretions of carbonates; dark-colored accumulations of oxides; moderately alkaline; gradual smooth boundary.

C2g—43 to 72 inches, olive gray (5Y 5/2) loam; many fine and medium prominent yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; massive; friable; strong effervescence; few carbonate concretions; few dark-colored accumulations of oxides; moderately alkaline.

The solum ranges from 20 to 36 inches in thickness. The reaction is mildly alkaline or moderately alkaline. The clay content between depths of 10 and 36 inches ranges from 20 to 35 percent. The A horizon is loam, clay loam, silty clay loam, or silt loam. It is black (N 2/0) to very dark gray (10YR 3/1) in color. The B2 horizon is dark gray (5Y 4/1) or dark grayish brown (2.5Y 4/2) in the upper part and olive gray (5Y 4/2 or 5/2) in the lower part. The texture of the B2 horizon is loam or clay loam. Calcium carbonate equivalent is less than 5 percent to about 15 percent, and it is higher in the C horizon than in the solum.

Canisteo soils are near Webster soils and formed in similar materials. Canisteo soils are calcareous, but Webster soils are leached of lime to the lower part of the B horizon.

507—Canisteo clay loam, 0 to 2 percent slopes. This soil is in slight depressions at heads of drainageways or on rims of depressions. Areas are irregular in shape and are about 5 to 20 acres.

Included with this soil in mapping are small areas of soils that are more limy than Canisteo soils; these are in sections 3 and 4 in Clear Creek Township. Also included are small depressional areas of Webster soils.

Canisteo soils are usually farmed with adjoining soils and planted to row crops. Wetness is a limitation. Surface drainage and tile drainage are both used. Maintaining good tilth is a problem. Fall plowing, artificial drainage, and timely field operations help to maintain tilth. Soil blowing is a hazard if this soil is plowed in fall. Practices that leave mulch on the surface help to control soil blowing. Organic matter content is high. Capability unit IIw–3; environmental planting group 2.

Chelsea series

The Chelsea series consists of excessively drained soils on convex ridgetops and side slopes on uplands adjacent to larger valleys. These soils formed in eolian sand under forest. Slopes are 4 to 40 percent.

In a representative profile the surface layer is very dark gray loamy fine sand about 3 inches thick. The subsurface layer is about 31 inches thick. It is brown loamy fine sand and fine sand in the upper part and yellowish brown fine sand in the lower part. Below this to a depth of 60 inches is yellowish brown fine sand with thin layers of dark yellowish brown loamy fine sand.

Permeability is rapid, and available water capacity is low. The available phosphorus and potassium in the subsoil are very low.

The Chelsea soils are used primarily for pasture. Drought and erosion are the major hazards.

Representative profile of Chelsea loamy fine sand, 4 to 9 percent slopes, in a timbered pasture, 330 feet north and 440 feet east of the southwest corner of the SE¼ sec. 27, T. 80 N., R. 21 W.:

A1—0 to 3 inches; very dark gray (10YR 3/1) loamy fine sand; weak fine granular structure; very friable; medium acid; abrupt smooth boundary.

A21—3 to 8 inches; brown (10YR 4/3) loamy fine sand; very dark grayish brown (10YR 3/2) coats on faces of peds; single grained; loose; medium acid; gradual smooth boundary.

A22—8 to 17 inches; brown (10YR 4/3) fine sand; single grained; loose; medium acid; clear smooth boundary.

A23—17 to 34 inches; yellowish brown (10YR 5/6) fine sand; single grained; loose; strongly acid; gradual smooth boundary.

A&B—34 to 60 inches, yellowish brown (10YR 5/4) fine sand; single grained; loose; thin dark yellowish brown (10YR 4/4) loamy fine sand bands; strongly acid; gradual smooth boundary.

The solum ranges from 4 feet to many feet in thickness. The A1 or Ap horizon ranges from very dark gray (10YR 3/1) to brown (10YR 4/3) in color. The brown (10YR 4/3) color is prominent in eroded and cultivated areas. Texture of the A horizon is loamy fine sand or fine sand. The A horizon is medium acid or strongly acid in reaction. The A&B horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4) in the upper part and grades to light yellowish brown (10YR 6/4) or yellowish brown (10YR 5/4) in the lower part.

Chelsea soils formed in the same kind of parent material and are on similar landscape positions as Sparta soils. Chelsea soils lack the moderately thick, dark colored surface layer that is characteristic of Sparta soils.

63C—Chelsea loamy fine sand, 4 to 9 percent slopes. This soil is on narrow, convex ridgetops and side slopes on the uplands. Areas are typically long, narrow, and irregularly shaped. Some areas are moderately wide and oblong. They are about 5 to 20 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Sparta and Fayette soils.

Most areas are used for pasture. Many areas are wooded. This soil is suited to permanent pasture and wildlife habitat. It is susceptible to severe erosion and is droughty. The hazard of soil blowing is severe, and maintaining a good plant cover is important. The organic matter content is very low. Capability unit IVs–1; environmental planting group 3.

63D—Chelsea loamy fine sand, 9 to 14 percent slopes. This soil is on convex side slopes on the uplands. Areas are moderately long, narrow, and irregular in shape and about 5 to 20 acres in size.

Included with this soil in mapping are small areas of nonsandy soils that are not droughty.

This soil is suited to permanent pasture and wildlife habitat. It is susceptible to severe erosion and is droughty. Soil blowing is a serious problem if plant cover is sparse. The organic matter content is very low. Capability unit VIs–1; environmental planting group 3.

63E—Chelsea loamy fine sand, 14 to 25 percent slopes. This soil is on convex side slopes. Areas are typically long and narrow and about 5 to 20 acres in size.

This soil has a profile similar to the one described as representative of the series but the surface layer is thinner and in small eroded areas brown material is at the surface.

Included with this soil in mapping are small areas of soils that formed in loess or glacial till. These soils are not so droughty as Chelsea soils.

This soil is suited to permanent pasture and wildlife habitat. Erosion, droughtiness, and soil blowing all are serious hazards. The organic matter content is very low. Capability unit VIIs–1; environmental planting group 3.

293G—Chelsea-Fayette complex, 25 to 40 percent slopes. The soils of this complex are on convex side slopes on the uplands. Areas are irregular in shape and range from 15 to 40 acres in size.

Fayette silt loam makes up about 40 percent of the complex, and Chelsea loamy fine sand makes up about 50 percent. The other 10 percent is soils that formed in a mixture of eolian sand and loess. Fayette silt loam generally occurs upslope from Chelsea loamy fine sand. These soils occur in such an intricate pattern that it was not practical to map them separately.

This complex is suited to pasture, woodland, or wildlife habitat. Most areas are wooded. The Chelsea soil in the complex is droughty and susceptible to soil blowing and erosion. The Fayette soil has rapid runoff and is susceptible to erosion. The organic matter content is low to very low. Capability unit VIIs–1; environmental planting group 3.

Clarinda series

The Clarinda series consists of poorly drained soils on side slopes and in coves at the heads of drainageways on the uplands. These soils formed in weathered glacial till under prairie grasses. Slopes are 5 to 14 percent.

In a representative profile the surface layer is very dark gray silty clay loam about 6 inches thick. The subsoil is dark gray to gray, firm silty clay and clay to a depth of 60 inches.

Permeability is very slow, and available moisture capacity is moderate. Available phosphorus is low, and potassium is low to medium in the subsoil.

These soils are used for cultivated crops and for hay and pasture. Erosion and wetness are serious hazards.

Representative profile of Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded, 500 feet east and 290 feet north of southwest corner of sec. 12, T. 80 N., R. 19 W.:

Ap—0 to 6 inches; very dark gray (10YR 3/1) silty clay loam, some mixing of dark grayish brown (10YR 4/2), very dark grayish brown (10YR 3/2) crushed; weak fine granular and subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

IIB1t—6 to 14 inches; mixed dark gray (10YR 4/1) and gray (10YR 5/1) silty clay; few fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; moderate very fine angular blocky and subangular blocky structure; firm; discontinuous clay films; few dark colored flows along channels; slightly acid; clear smooth boundary.

IIB21tg—14 to 25 inches; gray (5Y 5/1) clay; few fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; moderate fine and medium angular blocky structure; thin discontinuous clay films on faces of peds; firm; few dark streaks; medium acid; gradual smooth boundary.

IIB22tg—25 to 31 inches; gray (5Y 6/1) silty clay; few fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; moderate fine and medium angular blocky structure; firm; thick continuous clay films on faces of peds; few dark streaks; few fine white sand grains; slightly acid; gradual smooth boundary.

IIB23tg—31 to 40 inches; gray (5Y 6/1) silty clay; few fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; moderate medium angular blocky structure; firm; thick continuous clay films on faces of peds; few fine white sand grains; slightly acid; gradual smooth boundary.

IIB3tg—40 to 60 inches; gray (5Y 6/1) silty clay; few fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin continuous clay films on faces of peds; few fine white sand grains and dark minerals; slightly acid.

The solum is commonly more than 60 inches thick. In uneroded areas the A horizon ranges from 10 to 16 inches in thickness. The A horizon is black (10YR 2/1), very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The Ap horizon is silty clay loam or silt loam. The lower part of the A horizon is silty clay loam or silty clay. The IIB horizon is more than 40 percent clay. The gleyed part of the IIB horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma dominantly of 1.

In Jasper County, the A horizon of Clarinda soils is 6 to 10 inches thick in most places because of erosion. This is thinner than the defined range of the series, but this does not significantly affect the use of the soil.

Clarinda, Adair, Lamoni, and Shelby soils formed in somewhat similar parent materials and are associated in the landscape. Clarinda soils have less reddish hues and less sand in the solum than Adair soils and lack the stone line that is present in Adair soils.

Clarinda soils are more olive gray and are more clayey in the lower part of the B horizon and in the C horizon than Lamoni and Shelby soils.

222C2—Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded. This soil typically is in coves at the head of drainageways. Individual areas are narrow and irregularly shaped and range from 5 to 15 acres in size.

The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are some narrow drainageways, where silty local alluvium mantles the clayey sediments. Also included are some areas of uneroded Clarinda soils.

This soil is generally farmed with the adjoining soils and is used mainly for row crops. Some areas that are too wet in spring are left idle. Management of this soil is difficult. It is hard and cloddy when dry and sticky when wet, and it is susceptible to erosion. Interceptor tile upslope from this soil helps to reduce wetness. The organic matter content is moderate. Capability unit IVw–1; environmental planting group 2.

222D2—Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded. This soil is in narrow bands on side slopes or in coves at the heads of drainageways. Areas generally are 5 to 15 acres in size.

The plow layer of this soil is very dark grayish brown as a result of mixing with the dark gray material from the subsoil and is silty clay loam or silty clay in texture. Plowing has exposed the subsoil in severely eroded places. These spots are shown by a special symbol on the soil map.

Included with this soil in mapping are small areas of Adair or Lamoni soils. Also included are small areas of Clarinda soils that are just slightly eroded. A thin layer of loess is on the surface on the upper edge of this unit.

This soil is generally farmed with surrounding areas that are used for cultivated crops. Erosion is a serious hazard. This soil generally has poor tilth and is low to moderate in organic matter content. It puddles readily and is slow to absorb moisture. The surface layer becomes hard and cloddy and cracks readily when dry. Runoff is excessive. These soils are slow to dry out and remain wet for long periods. Interceptor tile upslope from this soil helps to reduce wetness. Capability unit IVe–2; environmental planting group 2.

Clarion series

The Clarion series consists of well drained soils on uplands. These soils formed in calcareous glacial till under prairie grasses. Slopes are 2 to 18 percent.

In a representative profile the surface layer is very dark brown loam about 12 inches thick (fig. 8). The subsoil extends to a depth of 32 inches; the upper 6 inches is very dark brown, friable loam, and the lower 14 inches is brown, friable loam. The substratum is yellowish brown and light brownish gray, calcareous loam.

Permeability is moderate, and available water capacity is high. Available phosphorus and potassium are very low in the subsoil.

Clarion soils are used mainly for cultivated crops. They are susceptible to erosion.

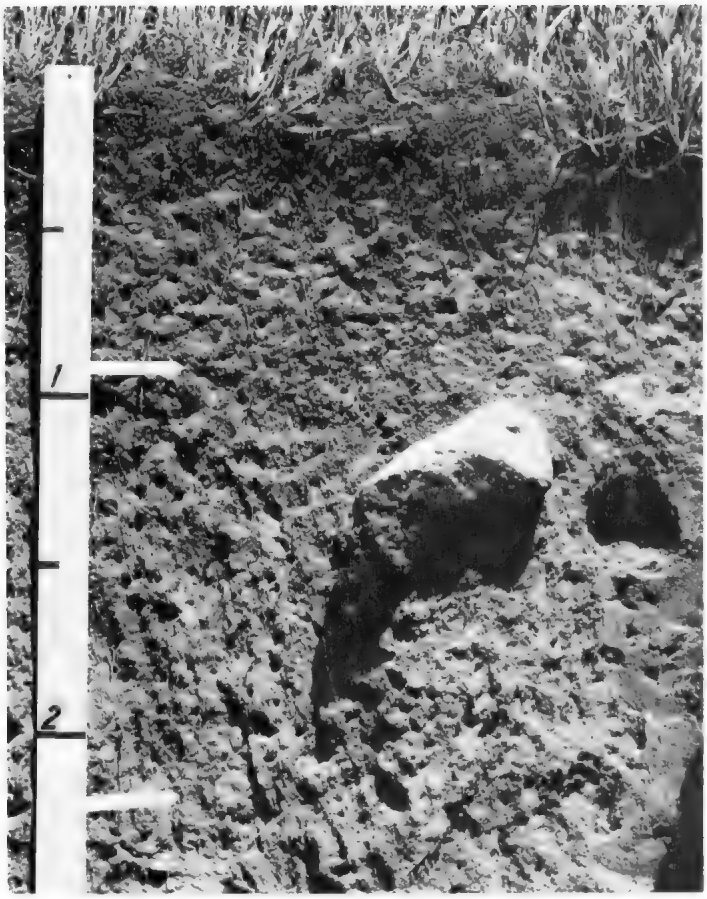

Figure 8.—**Profile of a Clarion loam. Pebbles and a few stones or boulders are typical in this soil.**

Representative profile of Clarion loam, 2 to 5 percent slopes, on a northwest-facing, convex slope in an alfalfa field, 100 feet south and 50 feet west of the northeast corner of sec. 10, T. 81 N., R. 21 W.:

Ap—0 to 6 inches; very dark brown (10YR 2/2) loam; weak fine granular structure; friable; neutral; gradual smooth boundary.

A12—6 to 12 inches; very dark brown (10YR 2/2) loam; weak fine granular structure; friable; neutral; gradual smooth boundary.

B1—12 to 18 inches; very dark brown (10YR 2/2) heavy loam; very dark grayish brown (10YR 3/2) crushed; weak fine granular and subangular blocky structure; friable; slightly acid; clear smooth boundary.

B21—18 to 24 inches; brown (10YR 4/3) heavy loam; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B22—24 to 32 inches; brown (10YR 4/3) heavy loam; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

C1—32 to 37 inches; yellowish brown (10YR 5/4) heavy loam; few fine faint grayish brown

(2.5Y 5/2) and few fine distinct strong brown (7.5YR 5/8) mottles; friable; slightly acid; massive; gradual smooth boundary.

C2—37 to 42 inches; yellowish brown (10YR 5/4) loam; few fine faint grayish brown (2.5Y 5/2) and few fine distinct strong brown (7.5YR 5/8) mottles; massive; friable; few prominent black accumulations of oxides; neutral; gradual smooth boundary.

C3—42 to 60 inches; mottled light brownish gray (10YR 6/2) and yellowish brown (10YR 5/6) loam; few fine distinct dark-colored accumulations of oxides and carbonate concretions; slight effervescence; mildly alkaline.

The solum ranges from 20 to 45 inches in thickness. The depth to carbonates is generally the same. The A1 horizon or Ap and A1 horizons are black (10YR 2/1), very dark brown (10YR 2/2), or very dark grayish brown (10YR 3/2) and are about 6 to 12 inches thick. The texture of the A horizon commonly is loam but is light clay loam in a few places. The B2 horizon ranges from dark brown (10YR 3/3) or brown (10YR 4/3) in the upper part to brown (10YR 4/3) or yellowish brown (10YR 5/4) in the lower part. It is 10 to 30 inches thick.

Clarion soils are near Nicollet and Storden soils and formed in similar parent material. The well drained Clarion soils have a browner subsoil than the somewhat poorly drained Nicollet soils. Clarion soils are leached of lime to a depth of at least 20 inches; Storden soils are calcareous at or near the surface.

138B—Clarion loam, 2 to 5 percent slopes. This soil is typically on convex knolls. Areas range from 5 acres to more than 20 acres in size. Many areas are round or oblong.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas, usually less than 3 acres in size, of soils in which drainage is restricted. Wet spots are indicated by a special symbol on the soil map. A few small knolls of Storden soils are also included in mapping and are indicated by a special symbol.

This soil is mostly cultivated and is well suited to row crops, which can be grown much of the time if erosion is controlled. Some conservation practices, such as terracing, are difficult to establish because slopes in this area are irregular. The organic matter content is moderate. Capability unit IIe–1; environmental planting group 1.

138C2—Clarion loam, 5 to 9 percent slopes, moderately eroded. This soil is on convex side slopes. Areas are typically 10 to 15 acres in size and irregular in shape.

The profile of this soil is similar to that described as representative of the series, but the surface layer is a very dark grayish brown plow layer that has some brown subsoil mixed into it in places. The depth to calcareous material is a few inches less than that described for the series.

Included with this soil in mapping are small knolls of Storden soils. Also included are some severely eroded spots, which are indicated by special symbols on the soil map.

This soil is moderately well suited to row crops and is usually used for corn and soybeans. Erosion should be controlled. Conservation practices, such as terracing, are difficult to establish in places because slopes are irregular. The organic matter content is moderate. Capability unit IIIe–1; environmental planting group 1.

138D2—Clarion loam, 9 to 14 percent slopes, moderately eroded. This soil is on convex side slopes. Areas are typically 10 to 30 acres in size and irregular in shape.

The profile of this soil is similar to that described as representative of the series, but the surface layer is a very dark grayish brown or brown plow layer. In many areas some of the subsoil material has been mixed into the surface or plow layer. The depth to calcareous material is less than is described in the representative profile.

Included with this soil in mapping are small knolls of Storden soils and some severely eroded spots. These areas are indicated by special symbols on the soil map.

This soil is used for cultivated crops and pasture. It is not suited to frequent row cropping unless conservation practices are established. The hazard of erosion is severe. Some practices, such as terracing, are difficult to establish because slopes are irregular. The organic matter content is moderate. Capability unit IIIe–3; environmental planting group 1.

138E2—Clarion loam, 14 to 18 percent slopes, moderately eroded. This soil is on convex side slopes. Areas are typically about 5 to 15 acres in size and irregular in shape.

This soil has a very dark grayish brown surface layer. It is thicker at the base of slopes and in pastures. Some of the subsoil material has been mixed into the plow layer in cultivated areas. The depth to calcareous material is less than is described in the representative profile.

Included with this soil in mapping are a few areas of soils that are calcareous at the surface. Small areas of severely eroded Clarion soils are also included. These areas are indicated by a special symbol on the soil map.

This soil is used mainly for hay or pasture, and it is well suited to these uses. Row crops can be occasionally grown if erosion is controlled. Erosion is a severe hazard. Gullying is a problem in places. The organic matter content is moderate. Capability unit IVe–1; environmental planting group 1.

Clinton series

The Clinton series consists of moderately well drained soils on uplands. These soils formed in loess under deciduous forest. Slopes are 5 to 18 percent.

In a representative profile the surface layer is very dark gray silt loam about 2 inches thick. The subsurface layer is dark grayish brown and grayish brown silt loam about 7 inches thick. The subsoil extends to a depth of 62 inches. It is brown, friable silty clay loam in the upper part and brown and dark yellowish brown, firm silty clay loam in the middle part. The lower part is brown, friable silty clay loam that has a few yellowish brown and grayish brown mottles.

Permeability is moderately slow, and available water capacity is high. The available phosphorus in the subsoil is high, and the available potassium in the subsoil is very low.

Clinton soils are mainly used for cultivated crops and pasture. Some areas are wooded. Erosion is the major hazard.

Representative profile of an uneroded Clinton soil in an area of Clinton silt loam, 5 to 9 percent slopes, moderately eroded, in a bluegrass and deciduous timber pasture, 700 feet west and 100 feet south of the northeast corner of sec. 31, T. 78 N., R. 21 W.:

A1—0 to 2 inches; very dark gray (10YR 3/1) silt loam; weak fine granular structure; friable; strongly acid; clear smooth boundary.

A2—2 to 9 inches; dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) silt loam; moderate medium platy structure, friable; medium acid; abrupt smooth boundary.

B1t—9 to 13 inches; brown (10YR 4/3) light silty clay loam; moderate medium subangular blocky structure; friable; thin discontinuous clay films; medium acid; gradual smooth boundary.

B21t—13 to 26 inches; brown (10YR 4/3) and dark yellowish brown (10YR 4/4) heavy silty clay loam, yellowish brown (10YR 5/4) crushed; strong medium subangular blocky structure; firm; thin discontinuous clay films; thin continuous light gray (10YR 7/3) dry silt coatings; strongly acid; gradual smooth boundary.

B22t—26 to 37 inches; brown (10YR 5/3) heavy silty clay loam; brown (10YR 4/3) coats; weak medium prismatic structure parting to strong medium angular blocky; firm; thin discontinuous clay films and thin continuous light gray (10YR 7/2) dry silt coatings, strongly acid; gradual smooth boundary.

B23t—37 to 46 inches; brown (10YR 5/3) heavy silty clay loam; brown (10YR 4/3) coats; few fine faint yellowish brown (10YR 5/8) and grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to strong medium angular blocky; friable; thin discontinuous clay films on vertical faces of peds; thin continuous light gray (10YR 7/2) dry silt coatings; few fine dark-colored accumulations of oxides; strongly acid; gradual smooth boundary.

B3t—46 to 62 inches; brown (10YR 5/3) silty clay loam, pale brown (10YR 6/3) dry; dark yellowish brown (10YR 4/4) coats; few fine faint yellowish brown (10YR 5/8) and grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to moderate medium angular blocky; friable; thin discontinuous clay films; thin continuous light gray (10YR 7/2) dry silt coatings; few fine dark mineral concretions; strongly acid.

The thickness of the solum typically is greater than 60 inches but ranges from 42 to 84 inches. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is 1 to 5 inches thick and is medium acid or strongly acid. The A2 horizon is dark grayish brown (10YR 4/2), grayish brown (10YR 5/2) or brown (10YR 5/3). It is 6 to 14 inches thick and is slightly acid to strongly acid. The B2 horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4). It is 18 to 36 inches thick and is medium acid to very strongly acid. The B3 horizon is dark yellowish brown (10YR 4/4), brown (10YR 5/3), or yellowish brown (10YR 5/4). It is 14 to 28 inches thick and ranges from medium acid to neutral. Soils that are olive gray in the matrix below a depth of 36 inches are also included in the series.

Clinton soils are near Lindley soils and formed in the same kind of parent materials as Ladoga soils. Clinton soils have a thinner A1 horizon than the Ladoga soils. They have less sand than Lindley soils and contain no gravel or pebbles, as do Lindley soils, which formed in glacial till.

80C2—Clinton silt loam, 5 to 9 percent slopes, moderately eroded. This soil is on narrow, convex ridgetops and side slopes on the upland. Areas are typically long and narrow and are from 5 acres to more than 30 acres in size.

The soil having the profile described as representative of the series was mapped in an area of this soil. In general, however, this soil has a profile similar to the one described as representative of the series, but erosion has removed the surface layer and a part of the subsurface layer. In plowed areas, some of the subsoil material has been mixed into the plow layer.

Included with this soil in mapping are areas of severely eroded soils and small areas where glacial till is exposed. These areas are indicated by special symbols on the soil map. Some uneroded areas are also included.

This soil is mainly used for cultivated crops. It is moderately well suited to row crops if erosion is controlled. It is very susceptible to erosion. The organic matter content is low to very low. Capability unit IIIe–1; environmental planting group 1.

80D2—Clinton silt loam, 9 to 14 percent slopes, moderately eroded. This soil is on narrow convex side slopes. Areas are typically long and narrow and are 5 acres to more than 40 acres in size.

This soil has a profile similar to the one described as representative of the series, but erosion has removed the surface layer and a part of the subsurface layer. The brown or dark yellowish brown subsoil is less than 10 inches below the surface. In plowed areas, some of the subsoil has been mixed into the plow layer.

Included with this soil in mapping are areas of severely eroded soils and areas where glacial till is exposed. These areas are indicated by special symbols on the soil map.

This soil is used for cultivated crops, hay, and pasture. It is moderately well suited to row crops but is well suited to small grain, hay, and pasture. It is susceptible to erosion. The organic matter content is very low. Capability unit IIIe–3; environmental planting group 1.

80E2—Clinton silt loam, 14 to 18 percent slopes,

moderately eroded. This soil is on narrow, convex side slopes. Areas are typically long and narrow and are 5 acres to more than 15 acres in size.

This soil has a profile similar to the one described as representative of the series, but erosion has removed the surface layer and a part of the subsurface layer. In plowed areas some of the subsoil has been mixed into the plow layer.

Included with this soil in mapping are areas of moderately steep Clinton soils and areas of uneroded Clinton soils. Also included are small areas of severely eroded soils and small areas of red clay, glacial till, and shale outcrop. These areas are indicated by special symbols on the soil map.

This soil is generally used for hay or pasture. Many areas are wooded. This soil is poorly suited to cultivated crops. Row crops can be grown occasionally if erosion is controlled, but this soil is very susceptible to erosion. The organic matter content is very low. Capability unit IVe–1; environmental planting group 1.

80D3—Clinton soils, 9 to 14 percent slopes, severely eroded. This soil is on convex side slopes. Areas are typically narrow and irregular in shape and are 5 to 10 acres in size.

This soil has a profile similar to the one described as representative of the series, but erosion has removed the original surface layer and most or all of the subsurface layer. The present surface layer is dark grayish brown silt loam or silty clay loam. The subsoil is brown and dark yellowish brown and is less than 3 inches below the surface. In some places it is exposed at the surface. In plowed areas the subsoil is mixed into the plow layer.

Included with this soil in mapping are areas of severely eroded Ladoga soils. Also included are areas where gray clay, glacial till, or shale is exposed at the surface. These areas are indicated by special symbols on the soil map.

Most areas of these soils are in hay or pasture. They are poorly suited to cultivated crops and are better suited to small grain, hay, and pasture. They are susceptible to erosion. The organic matter content is very low. Maintaining fertility and tilth is a concern of management. Capability unit IVe–3; environmental planting group 1.

Coland series

The Coland series consists of poorly drained soils that are mainly on first and second bottoms. These soils formed in loamy alluvium under prairie grasses that are tolerant to wetness. Slopes are 0 to 5 percent.

In a representative profile the surface layer is black clay loam and sandy clay loam about 39 inches thick. The substratum, to a depth of 60 inches, is black and very dark gray sandy clay loam that has many strong brown mottles.

Permeability is moderately slow, and available water capacity is high. Available phosphorus is low, and available potassium is very low in the subsoil.

Coland soils are mainly used for cultivated crops when artificial drainage is adequate. Flooding and wetness are the major hazards.

Representative profile of Coland clay loam, 0 to 2 percent slopes, in a cultivated field, 990 feet south and 1,100 feet west of the northeast corner of NW¼ sec. 4, T. 79 N., R. 21 W.:

Ap—0 to 6 inches; black (N 2/0) clay loam; weak fine granular structure; friable; neutral; gradual smooth boundary.

A12—6 to 20 inches; black (N 2/0) sandy clay loam; few fine faint strong brown (7.5YR 5/6 and 5/8) mottles; weak coarse prismatic structure parting to weak fine granular; friable; neutral; gradual smooth boundary.

A13—20 to 39 inches; black (10YR 2/1) sandy clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine granular structure; friable; neutral; gradual smooth boundary.

ACg—39 to 49 inches; black (10YR 2/1) sandy clay loam; few fine prominent strong brown (7.5YR 5/8) mottles; massive; friable; mildly alkaline; gradual smooth boundary.

C1g—49 to 54 inches; black (10YR 2/1) and very dark gray (10YR 3/1) sandy clay loam; many fine prominent strong brown (7.5YR 5/8) mottles; massive; friable; neutral; gradual smooth boundary.

C2g—54 to 61 inches; black (10YR 2/1) sandy clay loam; many medium prominent strong brown (7.5YR 5/8) mottles; massive; friable; slightly acid; clear smooth boundary.

The solum typically ranges from 36 to 48 inches in thickness. The A horizon ranges from black (N 2/0) to very dark gray (10YR 3/1). The A horizon typically is clay loam, but in places it is loam, sandy clay loam, or silty clay loam. The C horizon ranges from black (10YR 2/1) to grayish brown (10YR 5/2). Texture of the C horizon is sandy clay loam, sandy loam, or loamy sand.

In this county the content of sand is higher and the content of clay lower than the range defined for the Coland series. This does not significantly affect the use and behavior of the soils.

Coland and Colo soils are in similar positions on the landscape and have somewhat similar profiles. Coland soils have more sand in the profile than Colo soils.

135—Coland clay loam, 0 to 2 percent slopes. This soil is on first and second bottoms. Areas are typically long, broad, and irregular in shape, and in places they are more than 400 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of sandy soils. The sandy soils are mainly near the southwest corner of section 3 and the southeast corner of sec. 4, T. 79 N., R. 21 W. Also included are wet spots, which are indicated by a special symbol on the soil map.

This soil is well suited to corn, soybeans, and small grain if artificial drainage is adequate. It is susceptible to periodic flooding and wetness because of a high water table (fig. 9). The organic matter content is high.

Figure 9.—An area of Coland clay loam, 0 to 2 percent slopes.

Most of this soil is used for cultivated crops. It is well suited to this use if drainage is adequate and it is protected from flooding. Careful management practices are needed to maintain good tilth because of the wetness. Capability unit IIw–2; environmental planting group 2.

135B—Coland clay loam, 2 to 5 percent slopes. This soil is in narrow drainageways. Areas are typically long and narrow and range from 15 acres to more than 30 acres in size.

Included with this soil in mapping are small depressional areas, old channels, a few areas of calcareous soils, and small areas of Terril soils.

This soil is generally farmed with the adjoining upland soils and is planted to row crops in most years. It is well suited to this use if drainage is adequate and flooding is controlled. The organic matter content is high. Capability unit IIw–1; environmental planting group 2.

Colo series

The Colo series consists of poorly drained soils that formed in silty alluvium on bottom lands. Native vegetation was mainly prairie grasses. Slopes are 0 to 5 percent.

In a representative profile the surface layer is black silty clay loam 28 inches thick. It is underlain to a depth of 60 inches by very dark gray, black, and dark gray silty clay loam.

Permeability is moderately slow, and available water capacity is high. Available phosphorus in the subsoil is medium, and available potassium is very low.

Colo soils are used primarily for row crops. Wetness is the major limitation. Many areas are subject to flooding.

Representative profile of Colo silty clay loam, 0 to 2 percent slopes, in a cultivated field, 600 feet east and 86 feet north of the southwest corner of SE¼SW¼ sec. 24, T. 79 N., R. 20 W.:

Ap—0 to 8 inches; black (N 2/0) silty clay loam; moderate fine and medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A12—8 to 17 inches; black (N 2/0) silty clay loam; weak and moderate fine and medium subangular blocky structure; friable; neutral; diffuse smooth boundary.

A13—17 to 28 inches; black (N 2/0) silty clay loam; weak coarse prismatic structure parting to moderate fine subangular blocky; friable; neutral; diffuse smooth boundary.

AC—28 to 40 inches; very dark gray (N 3/0) silty clay loam; weak coarse prismatic structure; firm; neutral; diffuse smooth boundary.

C1g—40 to 48 inches; black (5Y 2/1) silty clay loam; few fine faint dark brown (7.5YR 4/4) mottles; weak coarse prismatic structure; firm; neutral; diffuse smooth boundary.

C2g—48 to 60 inches; dark gray (N 4/0) silty clay loam; massive; firm; neutral.

The solum ranges from 36 to 54 inches in thickness. Carbonates are absent from the solum. In places an overwash of very dark grayish brown (10YR 3/2) material 8 to 18 inches thick covers the surface. Colo soils are neutral to medium acid above a depth of 12 inches, and neutral or slightly acid below a depth of 12 inches. The A horizon is black (10YR 2/1) or very dark gray (10YR 3/1) in places. The texture is silty clay loam or silt loam. There is a weak structural B horizon that is very dark gray (10YR 3/1) in some pedons. The C horizon ranges from black (5Y 2/1 or N 2/0) in the upper part to dark gray (N 4/0) to dark grayish brown (2.5Y 4/2) below a depth of 40 inches. In a few places sand seams occur below a depth of 48 inches.

Colo soils are near Zook, Nodaway, Ackmore, and Ely soils and formed in the same kind of parent material. Colo soils have less clay in the subsoil than Zook soils, and they lack the recent stratified sediments typical of Nodaway and Ackmore soils. Colo soils are darker colored in the subsoil and are more poorly drained than Ely soils.

133+—Colo silt loam, overwash, 0 to 2 percent slopes. This soil typically is in narrow valleys downslope from strongly sloping to steep soils and on alluvial fans where small streams enter large valleys. Along the major streams it is in abandoned stream channels and in other places where sediments from flood waters accumulate readily. Areas are about 10 to 50 acres in size.

This soil has a profile similar to the one described as representative of the series, but 8 to 18 inches of very dark grayish brown overwash lies over the original black surface layer. The overwash is mainly silt loam but in some areas is silty clay loam.

This soil is well suited to row crops. Most areas are used for corn and soybeans. In narrow valleys and places subject to frequent flooding and ponding, this soil is generally used for pasture. Scattered trees are common in the pastures. Flooding and wetness are hazards. Except on lower elevations where water ponds, however, the surface layer of this soil dries out faster than the surface layer of other Colo soils. It is

easier to maintain good tilth. Organic matter content is moderate in the overwash material and high in the original buried surface layer. Capability unit IIw–2; environmental planting group 2.

133—Colo silty clay loam, 0 to 2 percent slopes. Areas of this soil range from about 5 acres to more than 100 acres in size in the large valleys and are irregularly shaped. In small valleys the areas are long and narrow and are about 5 to 20 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are some channeled areas that are unsuitable for row crops. Also included are areas that have silt loam overwash, some areas of clayey soils, and about 140 acres of a calcareous soil in sections 31, 32, and 33 of Clear Creek Township.

This soil is well suited to row crops. Most areas are used for corn and soybeans. Areas that are inaccessible or subject to frequent flooding are generally used for pasture. Flooding and wetness are hazards, and careful management practices are necessary to maintain good tilth. Organic matter content is high. Capability unit IIw–2; environmental planting group 2.

Dickinson series

The Dickinson series consists of well drained to somewhat excessively drained soils on uplands adjacent to major flood plains and on stream benches. These soils formed under prairie grasses in moderately coarse textured glacial drift, outwash, and alluvial sediments that have been reworked by wind. Slopes are 2 to 14 percent.

In a representative profile the surface layer is very dark brown and very dark grayish brown fine sandy loam 13 inches thick. The subsoil extends to a depth of 33 inches; it is dark brown, very friable fine sandy loam in the upper part and brown, very friable loamy sand in the lower part. The substratum is strong brown and yellowish brown loamy sand and sand.

Permeability is moderately rapid to rapid, and available water capacity is moderate. Available phosphorus and potassium are very low in the subsoil.

Dickinson soils are mainly used for cultivated crops. The major hazards are erosion, soil blowing, and droughtiness.

Representative profile of Dickinson fine sandy loam, 5 to 9 percent slopes, in a cultivated field, 1,020 feet west and 90 feet south of the northeast corner of sec. 19, T. 81 N., R. 21 W.:

Ap—0 to 5 inches; very dark brown (10YR 2/2) fine sandy loam; weak fine granular structure; friable; medium acid; clear smooth boundary.

A12—5 to 13 inches; very dark grayish brown (10YR 3/2) fine sandy loam; weak fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B1—13 to 24 inches; dark brown (10YR 3/3) fine sandy loam; weak fine subangular blocky structure; very friable; medium acid; gradual smooth boundary.

B2—24 to 33 inches; brown (10YR 4/3) loamy sand; weak very fine subangular blocky structure; very friable; neutral; gradual smooth boundary.

C1—33 to 42 inches; strong brown (7.5YR 5/6) sand; single grained; loose; neutral; gradual smooth boundary.

C2—42 to 50 inches; yellowish brown (10YR 5/8) sand; single grained; loose; few iron stains; neutral; gradual smooth boundary.

C3—50 to 56 inches; yellowish brown (10YR 5/6) loamy sand; single grained; very friable; thin iron bands; slightly acid; gradual smooth boundary.

C4—56 to 64 inches; yellowish brown (10YR 5/6) loamy sand; single grained; very friable; thin iron bands; slightly acid.

The solum ranges from 24 to 50 inches in thickness. Depth to loamy sand or sand ranges from 20 to 42 inches. The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is 10 to 20 inches thick and is medium acid or strongly acid. The B1 horizon is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3). It is 2 to 11 inches thick. The B2 horizon is dark grayish brown (10YR 3/2), dark brown (10YR 3/3), brown (10YR 4/3), dark yellowish brown (10YR 4/4), or yellowish brown (10YR 5/4 or 5/6). The lower part of the B2 horizon ranges from fine sandy loam to sand. The B2 horizon is 8 to 16 inches thick and ranges from strongly acid to neutral. The C horizon ranges from strong brown (7.5YR 5/6) to yellowish brown (10YR 5/8) and light yellowish brown (2.5YR 6/4) in color. Texture of the C horizon ranges from loamy fine sand to sand. The C horizon is neutral to slightly acid.

Dickinson soils formed in the same kind of parent materials as Chelsea and Sparta soils. Dickinson soils have less sand than the Chelsea and Sparta soils.

175B—Dickinson fine sandy loam, 2 to 5 percent slopes. This soil is on convex side slopes and ridgetops on uplands adjacent to major flood plains and on northwest-southeast oriented convex ridges on stream benches. Areas on the uplands are typically long, narrow, and irregular in shape. On the benches they are long, narrow, and elliptical.

This soil has a profile similar to the one described as representative of the series, but the surface layer is about 4 inches thicker.

Included with this soil in mapping are small areas where glacial till is exposed at the surface. These areas are indicated by a special symbol on the soil map. Also included are some places where the upper part of the profile is loam in texture.

This soil is moderately well suited to corn, soybeans, small grain, and alfalfa. It is susceptible to erosion and drought. The organic matter content is moderate. Capability unit IIIe–4; environmental planting group 1.

175C—Dickinson fine sandy loam, 5 to 9 percent slopes. This soil is on convex side slopes on uplands adjacent to major flood plains and on northwest-southeast oriented convex dunes on stream benches. Areas are typically long, narrow, and elliptical in shape and range from about 5 to 20 acres in size.

This soil has the profile described as representative for the series.

Included with this soil in mapping are areas of moderately eroded Dickinson soils. Also included are areas of severely eroded soils and areas where glacial till or shale is exposed at the surface. These areas are indicated by special symbols on the soil map.

This soil is used for cultivated crops and pasture. It is moderately well suited to row crops, but it is susceptible to erosion and drought. The organic matter content is moderate. Capability unit IIIe–4; environmental planting group 1.

175D—Dickinson fine sandy loam, 9 to 14 percent slopes. This soil is on convex side slopes on uplands adjacent to major flood plains. Areas are typically long and narrow and are about 5 to 20 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer is very dark grayish brown and is about 10 inches thick.

Included with this soil in mapping are areas of moderately eroded Dickinson soils. Slopes exceed 14 percent in places. In a few areas, loamy sand and sand are at a depth of less than 20 inches. Coarser materials are below a depth of 30 inches in some places.

This soil is mainly used for hay and pasture. It is suited to small grain, alfalfa, and pasture. Row crops can be grown occasionally if erosion is controlled. This soil is susceptible to erosion and drought. The organic matter content is generally moderate. Capability unit IVe–4; environmental planting group 1.

Downs series

The Downs series consists of well drained soils on ridgetops and side slopes on the uplands and on loess-covered benches adjacent to large streams. These soils formed in loess under trees and grass. Slopes are 0 to 18 percent.

In a representative profile the surface layer is very dark gray silt loam about 6 inches thick. The subsurface layer is dark grayish brown silt loam about 2 inches thick. The subsoil is brown, friable silty clay loam to a depth of 30 inches. Below this it is yellowish brown, friable silty clay loam and silt loam to a depth of 60 inches.

Permeability is moderate, and available water capacity is high. Available phosphorus in the subsoil is medium, and available potassium is very low.

Downs soils are mainly used for cultivated crops. Some areas are in pasture and hay. Some pastures contain scattered trees. Erosion is the major hazard.

Representative profile of Downs silt loam, 2 to 5 percent slopes, 910 feet north and 30 feet west of the southeast corner of SW¼ sec. 6, T. 81 N., R. 19 W.:

Ap—0 to 6 inches; very dark gray (10YR 3/1) silt loam; weak very thin and thin platy structure parting to moderate fine granular; friable; medium acid; clear smooth boundary.

A2—6 to 8 inches; dark grayish-brown (10YR 4/2) silt loam, dark grayish brown (10YR 4/2) rubbed; very dark grayish brown (10YR 3/2) coats on faces of peds; weak thin platy structure parting to weak fine subangular blocky and granular; friable; thin patchy silt coats; medium acid; clear smooth boundary.

B1t—8 to 15 inches; brown (10YR 4/3) silty clay loam, dark grayish brown (10YR 4/2) kneaded; moderate very fine angular and subangular blocky structure; friable; thin patchy silt coats and very dark grayish brown clay films; slightly acid; gradual smooth boundary.

B21t—15 to 24 inches; brown (10YR 4/3) silty clay loam, brown (10YR 5/3) rubbed; moderate fine subangular blocky structure; friable; thin patchy silt coats and thin discontinuous clay films; strongly acid; gradual smooth boundary.

B22t—24 to 30 inches; yellowish brown (10YR 5/4) silty clay loam; brown (10YR 5/3) coats on faces of peds; moderate fine and medium subangular and angular blocky structure; friable; thin patchy silt coats and thin discontinuous clay films; strongly acid; gradual smooth boundary.

B31t—30 to 39 inches; yellowish brown (10YR 5/4) silty clay loam; moderate medium and fine subangular blocky structure; friable; thin patchy silt coats and thin discontinuous clay films; strongly acid; gradual smooth boundary.

B32t—39 to 46 inches; yellowish brown (10YR 5/4) silt loam; weak coarse and medium subangular blocky structure; friable; thin patchy silt coats and thin discontinuous clay films; medium acid; gradual smooth boundary.

B33t—46 to 60 inches; yellowish brown (10YR 5/4) silt loam; few fine faint yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) mottles; weak, coarse prismatic structure; friable; thin patchy silt coats and thin discontinuous clay films; few dark-colored accumulations of oxides; medium acid.

The A1 horizon is 5 to 9 inches thick and is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The A2 horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 5/3) and is 2 to 4 inches thick. In cultivated areas the A2 horizon is mixed into the Ap horizon. Grayish mottles are few to common below a depth of 30 inches. In the B2t horizon the clay content ranges from 27 to 35 percent.

Downs soils are near Tama and Fayette soils. All of these soils formed in loess. Downs soils have a thinner and lighter colored A1 horizon than Tama soils, and they have an A2 horizon, which Tama soils lack. Downs soils have a thinner A2 horizon than Fayette soils. Silt coats are less prominent in the B horizon in Downs soils than in Fayette soils.

162—Downs silt loam, 0 to 2 percent slopes. This soil is on narrow upland divides. Areas are irregular in shape and 10 to 20 acres in size.

Included with this soil in mapping are small areas of somewhat poorly drained Atterberry soils. A few areas of Fayette soils also are included.

This soil is well suited to cultivated crops, and this is the primary use. There are no serious limitations.

Organic matter content is moderate. Capability unit I–1; environmental planting group 1.

162B—Downs silt loam, 2 to 5 percent slopes. This soil is on broad divides. Areas are irregular in shape and 5 acres to more than 40 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of moderately eroded Downs soils.

This soil is well suited to cultivated crops. Corn and soybeans are the main crops. This soil is susceptible to erosion. Organic matter content is moderate. Capability unit IIe–2; environmental planting group 1.

162C2—Downs silt loam, 5 to 9 percent slopes, moderately eroded. This soil is on convex upland divides and side slopes. Areas are irregular in shape and 10 to 85 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface and subsurface layers and some of the brown subsoil have been mixed by plowing. The plow layer is very dark grayish brown.

Included with this soil in mapping are some severely eroded areas. These areas are indicated by a special symbol on the soil map.

This soil is mainly used for cultivated crops. It is moderately well suited to row crops if erosion is controlled. Organic matter content is moderate. Capability unit IIIe–1; environmental planting group 1.

162D2—Downs silt loam, 9 to 14 percent slopes, moderately eroded. This soil is on convex side slopes. Areas are irregular in shape and 10 acres to more than 100 acres in size.

This soil has a profile similar to the one described as representative of the series, but the plow layer is dark brown and very dark grayish brown silt loam. The surface and subsurface layers and some of the brown subsoil have been mixed by plowing.

Included with this soil in mapping are some uneroded areas. Also included are severely eroded areas. These areas are indicated by a special symbol on the soil map.

This soil is used for cultivated crops, hay, and pasture. It is moderately well suited to row crops if erosion is controlled. It is very susceptible to erosion. Organic matter content is moderate. Capability unit IIIe–3; environmental planting group 1.

162E2—Downs silt loam, 14 to 18 percent slopes, moderately eroded. This soil is on convex side slopes. Areas are irregular in shape and range from 5 to 30 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer is very dark grayish brown silt loam and has been mixed with some of the brown subsoil. The brown subsoil material is exposed at the surface in some places. These areas are indicated by special symbols on the soil map. Waterways and gullies dissect the side slope in some places.

Most areas of this soil are cultivated. Corn and soybeans can be grown if erosion is controlled, but this soil is better suited to small grain, hay, or pasture. Erosion is a serious hazard. Organic matter content is moderate. Capability unit IVe–1; environmental planting group 1.

T162B—Downs silt loam, benches, 2 to 5 percent slopes. This soil is on stream benches that are about 10 to 20 feet higher than the flood plain. Areas are irregular in shape and range from about 5 to 30 acres in size.

This soil has a profile similar to the one described as representative of the series, but it is normally underlain by stratified alluvial deposits instead of by glacial till, as is typical in the uplands. This underlying material is at a depth of as little as about 6 feet. In some areas the underlying material is 10 to 15 feet deep.

Included with this soil in mapping are some areas of Ladoga soils that have a more clayey subsoil than Downs soils. Some moderately sloping soils are also included.

This soil is well suited to row crops. Corn and soybeans are the main crops. Erosion is a hazard. This soil receives runoff water from adjoining upland soils in places. This runoff increases the erosion hazard and causes siltation problems. The underlying alluvial material is commonly coarse textured and is rapidly permeable. This must be considered in the construction of reservoirs and other types of structures. Organic matter content is moderate. Capability unit IIe–2; environmental planting group 1.

T162C—Downs silt loam, benches, 5 to 9 percent slopes. This soil is on stream benches along large and intermediate streams. The benches are 15 feet or more above the flood plain. This soil slopes from the high part of the bench to the flood plain. Areas are irregular in shape and range from about 5 acres to 30 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface and subsurface layers commonly are mixed by plowing. The plow layer is very dark grayish brown. This soil is normally underlaid by stratified alluvial deposits instead of by glacial till, as is typical in the uplands. This underlying material is at a depth of as little as about 6 feet. In some areas the underlying material is 10 to 15 feet deep.

Included with this soil in mapping are some gently sloping Downs soils. Also included are some areas of moderately eroded Downs soils. These areas are indicated by special symbols on the soil map.

This soil is moderately well suited to row crops if erosion is controlled. Corn, soybeans, oats, and meadow are the major crops. The hazard of erosion is increased by excess water that runs off the adjoining upland soils and across this soil. The underlying alluvial material is commonly coarse textured and is rapidly permeable. This must be considered in the construction of reservoirs and other types of structures. Organic matter content is moderate. Capability unit IIIe–1; environmental planting group 1.

Ely series

The Ely series consists of somewhat poorly drained soils on foot slopes and alluvial fans. These soils formed in silty local alluvium and colluvium under tall grasses. Slopes are 2 to 5 percent.

In a representative profile the surface layer is black and very dark gray silty clay loam about 24 inches thick. The subsoil extends to a depth of 54 inches; it is friable silty clay loam and is very dark gray and very

dark grayish brown in the upper part, dark grayish brown and grayish brown in the middle part, and grayish brown in the lower part. The substratum is grayish brown light silty clay loam to a depth of 60 inches.

Permeability is moderate, and available water capacity is high. Available phosphorus and potassium are very low in the subsoil.

Ely soils are used for cultivated crops, hay, and pasture. The major hazard is runoff from adjacent uplands, which causes wetness, siltation, and rilling.

Representative profile of Ely silty clay loam, 2 to 5 percent slopes, 500 feet west and 300 feet south of the northeast corner of NW¼NE¼ sec. 24, T. 80 N., R. 21 W.:

Ap—0 to 9 inches; black (10YR 2/1) light silty clay loam; moderate fine granular structure; friable; medium acid; gradual smooth boundary.

A12—9 to 18 inches; black (10YR 2/1) silty clay loam; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

A13—18 to 24 inches; very dark gray (10YR 3/1) silty clay loam; very dark grayish brown (10YR 3/2) crushed; moderate fine subangular blocky structure; friable; thin patchy clay films and silt coatings on faces of peds; slightly acid; gradual smooth boundary.

B1—24 to 32 inches; very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) silty clay loam; few fine faint yellowish brown (10YR 5/4 and 5/6) mottles; weak medium subangular blocky structure; friable; thin patchy clay films and nearly continuous silt coatings on faces of peds; neutral; clear smooth boundary.

B2—32 to 39 inches; dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) silty clay loam; common medium prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; friable; thin patchy clay films and nearly continuous silt coats on faces of peds; neutral; clear wavy boundary.

B3—39 to 54 inches; grayish brown (10YR 5/2) silty clay loam; common coarse prominent yellowish red (5YR 4/8) and few moderate distinct grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; thin patchy clay films and silt coats on faces of peds; neutral; gradual smooth boundary.

C—54 to 60 inches; grayish brown (10YR 5/2) light silty clay loam; few medium prominent yellowish red (5YR 4/8) and yellowish brown (10YR 5/6) mottles; massive; neutral.

The thickness of the solum typically is more than 48 inches but ranges from 40 to 66 inches. The A horizon is heavy silt loam or silty clay loam. It is medium acid or slightly acid and is 20 to 30 inches thick. The B1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is 5 to 10 inches thick. It does not extend below a depth of 36 inches. The B2 and B3 horizons range from dark grayish brown (10YR 4/2) to brown (10YR 5/3) in color. Texture is light or medium silty clay loam. The B horizon is slightly acid or neutral.

Ely soils are formed in parent materials similar to those in which Judson and Colo soils formed and are near these soils. Ely soils are not so well drained as Judson soils and better drained than Colo soils.

428B—Ely silty clay loam, 2 to 5 percent slopes. This soil is on short, plane or slightly concave foot slopes and alluvial fans. Areas are narrow, irregularly shaped bands, generally less than 10 acres in size.

Included with this soil in mapping are small areas of poorly drained Colo soils. Stratified recent overwash is on the surface in places.

This soil is mainly used for cultivated crops. It is well suited to row crops. It is subject to runoff from soils that are upslope, causing wetness, siltation, and rilling. Controlling erosion and runoff on adjoining soils helps to curtail the problems created by the runoff from the upslope soils. Waterways and gullies dissect some areas. Organic matter content is high. Capability unit IIw–1; environmental planting group 1.

Fayette series

The Fayette series consists of well drained soils on convex ridgetops and side slopes on uplands. These soils formed in loess under deciduous forest. Slopes are 2 to 40 percent.

In a representative profile (fig. 10) the surface layer is very dark grayish brown silt loam about 3 inches thick. The subsurface layer is dark grayish brown silt loam about 4 inches thick. The subsoil is brown, friable silty clay loam to a depth of 37 inches. Below this it is yellowish brown, friable silty clay loam and silt loam to a depth of 55 inches. The substratum is yellowish brown silt loam to a depth of 60 inches.

Permeability is moderate, and available water capacity is high. Available phosphorus in the subsoil is high, and available potassium is very low.

The Fayette soils are mainly used for cultivated crops and pasture. Some areas are wooded. Erosion is the major hazard.

Representative profile of an uneroded Fayette soil in an area of Fayette silt loam, 9 to 14 percent slopes, moderately eroded, in a pasture, 80 feet south and 66 feet west of the northeast corner of SE¼NE¼ sec. 13, T. 81 N., R. 21 W.:

A1—0 to 3 inches; very dark grayish brown (10YR 3/2) silt loam; grayish brown (10YR 5/2) dry; weak fine granular and weak thin platy structure; friable; slightly acid; clear smooth boundary.

A2—3 to 7 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) and light gray (10YR 7/2) dry; weak thin platy structure; friable; medium acid; clear irregular boundary.

B1t—7 to 12 inches; brown (10YR 4/3) light silty clay loam; moderate medium sub-

Figure 10.—**Profile of a Fayette silt loam. The thin surface layer and light-colored subsurface layer are typical in this soil.**

angular blocky structure; friable; thin discontinuous silt coats and clay films on faces of peds; strongly acid; gradual smooth boundary.

B21t—12 to 19 inches; brown (10YR 4/3) silty clay loam; strong medium angular and subangular blocky structure; friable; thin discontinuous silt coats and clay films on faces of peds; strongly acid; gradual smooth boundary.

B22t—19 to 24 inches; brown (10YR 4/3) silty clay loam; few brown (7.5YR 4/4) coats on faces of peds; strong medium angular and subangular blocky structure; friable; thin continuous silt coats and clay films on faces of peds; strongly acid; gradual smooth boundary.

B23t—24 to 30 inches; brown (10YR 4/3) silty clay loam; strong medium angular and subangular blocky structure; friable; thin continuous silt coats and clay films on faces of peds; strongly acid; gradual smooth boundary.

B24t—30 to 37 inches; brown (10YR 4/3) silty clay loam; strong medium angular and subangular blocky structure; friable; thin continuous silt coats and clay films on faces of peds; strongly acid; gradual smooth boundary.

B31t—37 to 45 inches; yellowish brown (10YR 5/4) silty clay loam; few distinct yellowish red (5YR 5/6) mottles; weak medium angular and subangular blocky structure; thin discontinuous silt coats and clay films on faces of peds; medium acid; gradual smooth boundary.

B32—45 to 55 inches; yellowish brown (10YR 5/4) silt loam; few fine faint grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure; friable; few discontinuous silt coats on faces of peds; medium acid; gradual smooth boundary.

C—55 to 65 inches; yellowish brown (10YR 5/4) silt loam; few fine faint grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) mottles; massive; friable; thin discontinuous silt coats; medium acid.

The solum typically ranges from 42 to 60 inches in thickness. The A1 horizon is black (10YR 2/1), very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2), or very dark brown (10YR 2/2). It is 1 to 4 inches thick and ranges from very strongly acid to neutral. The A2 horizon is dark gray (10YR 4/1) or dark grayish brown (10YR 4/2). It is 4 to 12 inches thick and ranges from very strongly acid to neutral. The B21t horizon is very strongly acid to medium acid. The C horizon is dark yellowish brown (10YR 4/4) or yellowish brown (10YR 5/4 or 5/6). The C horizon is silt loam or silty clay loam. It ranges from medium acid to neutral.

Fayette soils are near Lindley soils and formed in parent material similar to that of Downs soils. Fayette soils have a thinner A1 horizon than Downs soils. Fayette soils are upslope from Lindley soils, which formed in glacial till.

163B—Fayette silt loam, 2 to 5 percent slopes. This soil is on narrow, convex ridgetops. Areas are typically long, narrow, and irregular in shape and are about 20 acres in size.

In unplowed areas the profile of this soil is similar to that described as representative of the series. In cultivated areas this soil has a dark grayish brown surface layer that is a mixture of the original surface and subsurface layers. In a few areas material from the brown subsoil has been mixed into the plow layer.

This soil is used mainly for cultivated crops. It is well suited to row crops if erosion is controlled. Organic matter content is low. Capability unit IIe–2; environmental planting group 1.

163C2—Fayette silt loam, 5 to 9 percent slopes, moderately eroded. This soil is on convex ridgetops and side slopes. Areas are typically long and narrow on ridgetops or are bands on side slopes and range from 10 to 20 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer is a mixture of the original surface and subsurface layers and part of the subsoil. This plow layer is dark grayish brown.

Included with this soil in mapping are small areas of severely eroded soils and small areas of sandy soils. These areas are indicated by special symbols on the

soil map. Also included are some areas of slightly eroded soils.

This soil is mainly used for cultivated crops. Some areas are wooded or are in pasture. The soil is moderately well suited to row crops if erosion is controlled. Organic matter content is low to very low. Capability unit IIIe–1; environmental planting group 1.

163D2—Fayette silt loam, 9 to 14 percent slopes, moderately eroded. This soil is on side slopes. Areas are typically long, narrow bands that range from 10 to 30 acres in size.

This soil has a profile similar to the one described as representative of the series, but in cultivated areas the surface layer is a mixture of the original surface and subsurface layers and the upper part of the subsoil. This plow layer is dark grayish brown.

Included with this soil in mapping are small areas of severely eroded soils, exposed glacial till spots, and small areas of red clay soils. These areas are indicated by special symbols on the soil map.

This soil is used for cultivated crops, hay, and pasture. Some areas are wooded. This soil is moderately well suited to row crops if erosion is controlled. Organic matter content is low to very low. Capability unit IIIe–3; environmental planting group 1.

163E2—Fayette silt loam, 14 to 18 percent slopes, moderately eroded. This soil is on convex side slopes. Areas are typically long narrow bands that range from 10 to 25 acres in size.

This soil has a profile similar to the one described as representative of the series, but erosion has removed the surface layer and the dark grayish brown subsurface layer is exposed at the surface. In cultivated areas the surface layer is a mixture of the original surface and subsurface layers and the upper part of the subsoil. About 180 acres of uneroded soils is in this unit.

Included with this soil in mapping are small, severely eroded areas, small areas of glacial till, and small areas of red clay. These areas are indicated by special symbols on the soil map.

This soil is mainly used for hay and pasture. Some areas are wooded. This soil is better suited to hay, pasture, or woodland but can be row-cropped occasionally. It is very susceptible to erosion. Organic matter content is low to very low. Capability unit IVe–1; environmental planting group 1.

163F2—Fayette silt loam, 18 to 25 percent slopes, moderately eroded. This soil is on side slopes. Deep gullies dissect the soil in places. Areas are long narrow bands. They form the entire side slope in places and are 10 to 15 acres in size.

This soil has a profile similar to the one described as representative of the series, but erosion has removed the surface layer and the dark grayish brown subsurface layer is exposed at the surface.

Included with this soil in mapping are a number of areas of slightly eroded Fayette soils. Some areas of steep Downs soils are also included. Some areas of severely eroded soils are included and are indicated by special symbols on the soil map. Small areas of sand and small areas of glacial till are also indicated by special symbols on the soil map.

This soil is mainly used for pasture or woodland. Row crops are generally not suited except as an occasional crop in renovating a pasture. This soil is very susceptible to erosion. Organic matter content is low to very low. Capability unit VIe–1; environmental planting group 1.

163D3—Fayette soils, 9 to 14 percent slopes, severely eroded. Areas of this soil are typically long narrow bands on side slopes. The areas range from about 10 to 20 acres in size.

This soil has a profile similar to the one described as representative of the series, but erosion and plowing have mixed the original surface and subsurface layers with the upper part of the subsoil. The texture of the plow layer is commonly silty clay loam, but in places it is silt loam.

Included with this soil in mapping are many areas of strongly sloping Downs soils that are severely eroded. Also included are small areas of sand and small areas of red clay and glacial till; these areas are indicated by special symbols on the soil map. Small areas on ridgetops that have slopes of less than 9 percent are also included.

This soil is well suited to hay, pasture, or woodland, but it can be occasionally used for row crops. It is very susceptible to erosion. Maintaining good tilth is more of a problem than on other Fayette soils because the surface layer is made up mostly of the silty clay loam from the subsoil. Organic matter content is very low. Capability unit IVe–3; environmental planting group 1.

Flagler series

The Flagler series consists of somewhat excessively drained soils on stream benches. These soils formed in sandy loam alluvium overlying sand and gravel. Native vegetation was prairie grasses. Slopes are 1 to 4 percent.

In a representative profile the surface layer is black sandy loam 15 inches thick. The subsoil is very friable sandy loam 17 inches thick; it is very dark brown in the upper part and very dark grayish brown in the lower part. The substratum is brown loamy sand to a depth of 48 inches and brown and dark yellowish brown sand and gravel to a depth of 60 inches or more.

Permeability is moderately rapid in the upper part of the profile and very rapid in the substratum. Available water capacity is moderate. Available phosphorus in the subsoil is low, and available potassium is very low.

Flagler soils are used for cultivated crops. The soils are susceptible to droughtiness and soil blowing.

Representative profile of Flagler sandy loam, 1 to 4 percent slopes, in a cultivated field, 70 feet west and 70 feet south of the northeast corner of the NE¼ NW¼ sec. 20, T. 81 N., R. 21 W.:

Ap—0 to 7 inches; black (10YR 2/1) sandy loam, very dark brown (10YR 2/2) kneaded; weak fine granular structure; very friable; strongly acid; gradual smooth boundary.

A12—7 to 15 inches; black (10YR 2/1) sandy loam, very dark brown (10YR 2/2) kneaded; weak fine granular structure; very friable; slightly acid; gradual smooth boundary.

B1—15 to 22 inches; very dark brown (10YR 2/2) sandy loam; weak fine granular structure; very friable; slightly acid; clear wavy boundary.

B2—22 to 32 inches; very dark grayish brown (10YR 3/2) sandy loam; weak medium subangular blocky structure; very friable; neutral; clear smooth boundary.

IIC1—32 to 48 inches; brown (10YR 4/3) loamy sand; single grained; very friable; few small pebbles; neutral; clear smooth boundary.

IIC2—48 to 60 inches; brown (10YR 4/3 and 5/3) and dark yellowish brown (10YR 4/4) coarse sand and gravel; single grained; loose; slight effervescence; mildly alkaline.

The solum is 20 to 40 inches thick. The depth to loamy sand, sand, gravelly loamy sand, or gravel is typically 20 to 36 inches and is variable within short distances. The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). It is sandy loam or fine sandy loam. The A horizon is about 12 to 24 inches thick. The B2 horizon is very dark grayish brown (10YR 3/2), dark brown (10YR 3/3), brown (10YR 4/3), dark yellowish brown (10YR 4/4), or yellowish brown (10YR 5/4). The IIC horizon ranges from loamy sand to sand and gravelly sand.

Flagler soils in this county have a color value of 3 to a greater depth, are less acid, and contain free carbonates at a shallower depth than is defined in the range for the series. This does not significantly affect the use and behavior of these soils.

Flagler soils are near Dickinson and Lawler soils on benches. Flagler soils contain more gravel-size particles, especially below a depth of 30 inches, than Dickinson soils. They are coarser textured and better drained than Lawler soils.

284B—Flagler sandy loam, 1 to 4 percent slopes. This soil is on benches adjacent to the larger streams. Areas are typically irregular in shape and 10 to 60 acres in size.

Included with this soil in mapping are small areas of soils in which sand and gravel are at a depth of less than 20 inches. The coarser sand and gravel typical of this Flagler soil are absent in the substratum in a few places. Also included are poorly drained soils in depressions of less than ½ acre, which are indicated by a special symbol on the soil map.

Nearly all of this soil is used for cultivated crops. It is well suited to row crops. Droughtiness, soil blowing, and, in the sloping areas, erosion are hazards. Practices that leave crop residue on the surface are needed. Organic matter content is moderate. Capability unit IIs–1; environmental planting group 1.

Gara series

The Gara series consists of moderately well drained to well drained soils that are on side slopes adjacent to drainageways on uplands. These soils formed in glacial till under prairie grasses and timber. Slopes are 9 to 40 percent.

In a representative profile the surface layer is very dark gray loam 6 inches thick. The subsurface layer is dark grayish brown loam 6 inches thick. The subsoil is dark yellowish brown and yellowish brown, firm clay loam that extends to a depth of 42 inches. The substratum is grayish brown clay loam to a depth of 60 inches.

Permeability is moderately slow, and available water capacity is high. Available phosphorus in the subsoil is very low or low, and available potassium is very low.

Gara soils are mainly used for pasture, but some of the less sloping soils are used for cultivated crops. Some areas are wooded. Erosion is a hazard.

Representative profile of an uneroded Gara soil in an area of Gara loam, 14 to 18 percent slopes, moderately eroded, in a wooded pasture, 80 feet east and 650 feet north of the southwest corner of SE¼SE¼ sec. 10, T. 79 N., R. 19 W.:

A1—0 to 6 inches; very dark gray (10YR 3/1) loam; weak very fine granular structure; friable; slightly acid; clear smooth boundary.

A2—6 to 12 inches; dark grayish brown (10YR 4/2) loam; weak thin platy structure parting to weak fine subangular blocky; friable; strongly acid; clear smooth boundary.

B21t—12 to 18 inches; dark yellowish brown (10YR 4/4) clay loam; brown (10YR 4/3) coats on faces of peds; few fine faint yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; firm; thin discontinuous silt coats and clay films; medium acid; clear smooth boundary.

B22t—18 to 25 inches; dark yellowish brown (10YR 4/4) clay loam; few fine faint yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; firm; thin discontinuous grayish brown (10YR 5/2) silt coats and thin discontinuous clay films on faces of peds; few fine dark-colored accumulations of oxides; medium acid; gradual smooth boundary.

B23t—25 to 38 inches; yellowish brown (10YR 5/4 and 5/6) clay loam; common fine distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; thin discontinuous clay films and thin discontinuous grayish brown (10YR 5/2) silt coats; few dark-colored accumulations of oxides; few pebbles; medium acid; clear smooth boundary.

B3t—38 to 42 inches; yellowish brown (10YR 5/4 and 5/6) clay loam; common medium distinct grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to moderate medium angular and subangular blocky; firm; thin discontinuous silt coats and clay films; few soft carbonate accumulations; few dark-colored accumulations of oxides;

few pebbles and stones; slight effervescence; mildly alkaline; gradual smooth boundary.

C—42 to 60 inches; grayish brown (10YR 5/2) clay loam; common fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; massive and some vertical cleavage; firm; common fine and medium soft carbonate accumulations; few dark-colored accumulations of oxides; strong effervescence; mildly alkaline.

The thickness of the solum and depth to carbonates typically range from 40 to 48 inches. A few pebbles and stones are throughout the profile. The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) mixed with dark grayish brown (10YR 4/2) and dark yellowish brown (10YR 4/4). The B2t horizon is brown (10YR 4/3 or 5/3), dark yellowish brown (10YR 4/4), or yellowish brown (10YR 5/4); the darker colors are commonly in the upper part. The B2t horizon has an average of 32 to 35 percent clay.

The Gara soil in the Gara-Armstrong complex, 14 to 18 percent slopes, severely eroded, (993E3) typically has an Ap horizon that is brown (10YR 4/3) or dark grayish brown (10YR 4/2), and for this reason this soil is not within the range defined for the series. However, it is within the range defined for the series in all other properties.

Gara soils formed in the same kind of parent material as Shelby and Lindley soils and are in similar positions on the landscape. Gara soils have a thinner, lighter colored surface layer than Shelby soils. In areas not plowed they have an A2 horizon, which Shelby soils lack. Gara soils have a thicker, darker colored surface layer than Lindley soils.

179D2—Gara loam, 9 to 14 percent slopes, moderately eroded. This soil is generally on the lower part of convex side slopes. Areas are long and irregular in shape and are typically 10 to 30 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer is very dark grayish brown. Where plowed, the surface layer consists of a mixture of the original surface and subsurface layers and some material from the subsoil.

Included with this soil in mapping are small areas of Adair and Armstrong soils. Also included are small areas of severely eroded soils and, in a few places along downslope edges, areas of exposed shale. These areas are indicated by special symbols on the soil map. Some areas of strongly sloping Gara soils that are not eroded are also included.

This soil is used for cultivated crops, hay, or pasture. Row crops can be grown occasionally if erosion is controlled, but this soil is better suited to hay and pasture. Organic matter content is moderately low to low. Capability unit IVe–1; environmental planting group 1.

179E2—Gara loam, 14 to 18 percent slopes, moderately eroded. This soil is generally on the lower part of convex side slopes. Areas are long and irregular in shape and typically are 10 to 40 acres in size.

In areas that have been plowed, the surface layer is very dark grayish brown and has been mixed with material from the dark yellowish brown subsoil. Otherwise, the profile of this soil is similar to the one described as representative of the series.

Included with this soil in mapping are small areas of Adair and Armstrong soils. Also included are small severely eroded areas and, in a few places near the base of slopes, small exposed areas of shale. These areas are indicated by special symbols on the soil map. Some areas of moderately steep Gara soils that are not eroded are also included.

This soil is better suited to pasture and meadow than to row crops. Runoff is rapid, and the hazard of erosion is very severe. Organic matter content is low, and tilth is generally poor. Capability unit VIe–1; environmental planting group 1.

179F2—Gara loam, 18 to 25 percent slopes, moderately eroded. This soil is on convex side slopes. Areas are long and irregular in shape and range from 10 to 25 acres in size.

This soil has a profile similar to the one described as representative of the series, but this soil has lost some of the surface and subsurface layers because of erosion. In areas that have been plowed, the plow layer is a mixture of the surface and subsurface layers and a part of the subsoil.

Included with this soil in mapping are small areas of severely eroded Gara soils and, in a few places near bases of the slopes, small areas of exposed shale. These areas are indicated by special symbols on the soil map. Some areas of steep Gara soils that are not eroded are also included.

This soil is in trees and permanent pasture. It is suited to these uses and to wildlife habitat. It is generally not suited to row crops, because the hazard of erosion is very severe. Organic matter content is low. Capability unit VIIe–1; environmental planting group 1.

179G—Gara loam, 25 to 40 percent slopes. This soil is on convex side slopes. Areas are irregular in shape and 10 to 25 acres in size.

Included with this soil in mapping are small exposed areas of shale, which are indicated by a special symbol on the soil map.

This soil generally is in trees and permanent pasture. It is suited to these uses and to wildlife habitat. It is too steep for cultivated crops. Runoff is very rapid, and the hazard of erosion is very severe. Organic matter content is low. Capability unit VIIe–1; environmental planting group 1.

993D2—Gara-Armstrong loams, 9 to 14 percent slopes, moderately eroded. The soils of this complex are on convex side slopes in the upper reaches of drainage systems. Areas are generally long and less than 600 feet wide and are in a ribbonlike pattern that follows the contour of the side slope. Armstrong loam is on convex knobs and shoulders on upper parts of the side slopes. Gara loam is on convex, smooth side slopes below the Armstrong soil. The Gara soil makes up about 50 percent of a given area and the Armstrong soil about 40 percent. The remaining 10 percent is other soils.

Included with this complex in mapping are small areas of gray clay in the upper reaches of drainage systems. Special symbols are used on the soil map to

indicate the gray clay and wet areas commonly associated with the gray clay. Also included are some areas of soils that have a surface layer of clay loam.

Many areas of this complex are in cultivated crops. Some areas are in hay or pasture. This complex is better suited to hay and pasture than to most other uses. Row crops can be grown occasionally if erosion is controlled. Wet areas are common along the upper edge of this complex. Organic matter content generally is low to moderately low. Capability unit IVe–2; environmental planting group 1.

993E2—Gara-Armstrong loams, 14 to 18 percent slopes, moderately eroded. The soils of this complex are on convex side slopes in the upper reaches of drainage systems. Commonly, areas are long and about 600 feet wide and follow the contour of the side slopes. The Armstrong soil is on convex knobs and shoulders on the upper parts of slopes, and the Gara soil is on convex, smooth side slopes below the Armstrong soil. The Armstrong soil makes up about 30 percent of typical areas, and the Gara soil makes up about 50 percent. The remaining 20 percent is other soils.

Included with this complex in mapping are small areas of gray clay and some areas of severely eroded soils. These areas are shown on the soil map by special symbols. Also included are some areas of soils that have a surface layer of clay loam.

This complex is well suited to hay and pasture, and it is usually used for these purposes. It can be planted to row crops occasionally as a first step in renovating the pasture. It is susceptible to sheet and gully erosion. Wet areas are common along the upper edges of this complex. Organic matter content generally is low. Capability unit VIe–2; environmental planting group 1.

993E3—Gara-Armstrong complex, 14 to 18 percent slopes, severely eroded. The soils of this complex are on convex side slopes in the upper reaches of drainage systems. Commonly, areas are long and about 600 feet wide and follow the contour of side slopes. The Armstrong soil is on convex knobs and shoulders on the upper part of the side slopes, and the Gara soil is on convex, smooth side slopes below the Armstrong soil. The Armstrong soil makes up about 30 percent of typical areas, and Gara soil makes up about 50 percent. The remaining 20 percent is other soils.

In most places these soils have a surface layer that is clay loam, but in a few places it is loam. The Armstrong soil has a surface layer of clay in a few areas. The texture of the surface layer depends on the amount of the original surface layer that has been removed and the amount of subsurface and subsoil material that has been mixed into the plow layer. The plow layer is brown or dark grayish brown.

Included with this complex in mapping are some areas of moderately steep Gara and Armstrong soils that are slightly or moderately eroded. Also included are some areas of strongly sloping Armstrong soils.

Most areas of this complex are in pasture, but some are in cultivated crops. The soils are moderately well suited to pasture. The hazard of erosion is severe. Tilth is generally poor. The subsoil is exposed in most areas, and it hardens and cracks when it dries. Wet areas are common along the upper edges of this complex. Organic matter content is low. Capability unit VIIe–1; environmental planting group 1.

Garwin series

The Garwin series consists of poorly drained soils on uplands. These soils formed in loess under tall prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black and very dark gray silty clay loam about 17 inches thick. The subsoil extends to a depth of 49 inches; it is friable silty clay loam and is very dark gray in the upper part, dark gray in the middle part, and olive gray in the lower part. The substratum is olive gray silt loam that has many, coarse, prominent yellowish brown mottles.

Permeability is moderately slow, and available water capacity is high. Available phosphorus and potassium are very low in the subsoil.

Garwin soils are mainly used for cultivated crops. The hazard of wetness is the major limitation.

Representative profile of Garwin silty clay loam, 0 to 2 percent slopes, in a cultivated field on a slightly concave position, 150 feet north and 125 feet west of the southeast corner of the SW¼SE¼ sec. 28, T. 80 N., R. 18 W.:

Ap—0 to 6 inches; black (N 2/0) silty clay loam; weak fine granular structure; friable; medium acid; gradual smooth boundary.

A12—6 to 11 inches; black (N 2/0) silty clay loam; moderate fine and medium granular structure; friable; medium acid; gradual smooth boundary.

A13—11 to 17 inches; very dark gray (10YR 3/1) silty clay loam; moderate medium granular and weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B1g—17 to 22 inches; very dark gray (10YR 3/1) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate very fine and fine subangular blocky structure; friable; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B21g—22 to 29 inches; dark gray (10YR 4/1) silty clay loam; coatings of very dark gray (10YR 3/1) material; common fine distinct yellowish red (5YR 4/6) mottles; weak medium prismatic structure parting to moderate fine and medium subangular blocky; friable; thin discontinuous clay films; slightly acid; clear smooth boundary.

B22g—29 to 39 inches; dark gray (5Y 4/1) silty clay loam; common coarse faint olive gray (5Y 5/2) and few fine prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to coarse medium subangular blocky; friable; thin discontinuous clay films; neutral; gradual smooth boundary.

B3g—39 to 49 inches; olive gray (5Y 5/2) silty clay loam; many coarse prominent yellowish brown (10YR 5/8) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; dark worm coats; few dark-colored

accumulations of oxides; neutral; gradual smooth boundary.

C—49 to 60 inches; olive gray (5Y 5/2) silt loam; many coarse prominent yellowish brown (10YR 5/8) mottles; massive; dark worm coats; few dark-colored accumulations of oxides; mildly alkaline.

The solum ranges from 40 to 60 inches in thickness. Depth to carbonates ranges from 50 to 72 inches. The A horizon is 14 to 24 inches thick and is slightly acid or medium acid. The Ap horizon is black (10YR 2/1) or (N 2/0) in color. The B2g horizon ranges from very dark gray (10YR 3/1) to dark gray (5Y 4/1). Clay content averages between 30 and 35 percent. The B2g horizon is dark gray (5Y 4/1), gray (5Y 5/1), or grayish brown (2.5Y 5/2). The texture is heavy silt loam or silty clay loam. The C horizon ranges from dark grayish brown (2.5Y 4/2) to light olive gray (5Y 6/2). The texture is silt loam or light silty clay loam.

Garwin soils formed in the same kind of parent material as Sperry and Muscatine soils and are near those soils. Garwin soils lack the A2 horizon present in Sperry soils. Garwin soils are poorly drained, but Muscatine soils are somewhat poorly drained.

118—Garwin silty clay loam, 0 to 2 percent slopes. This soil is on plane or slightly concave uplands. Individual areas are broad and irregular in shape and range from 10 acres to more than 160 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of less than 1 acre of Sperry soils. These areas are indicated by special symbols on the soil map. Some areas of soils that have a slightly more clayey subsoil than is typical for Garwin soils are also included.

This soil is well suited to row crops. Corn and soybeans are the major crops. Wetness is a hazard, and timely field operations are needed to maintain good tilth. Tile drains are commonly used to improve drainage. Organic matter content is high. Capability unit IIw–3; environmental planting group 2.

117—Garwin-Sperry complex, 0 to 2 percent slopes. These soils are on broad upland divides. Garwin silty clay loam makes up 60 percent or more of the area. Sperry silt loam occupies small depressional areas surrounded by the Garwin soil. Areas of this complex are irregular in shape and are about 10 to 30 acres in size.

Included with this complex in mapping are areas of somewhat poorly drained Muscatine soils on the more convex parts of the landscape.

Corn and soybeans are the major crops grown on this complex. This complex is well suited to cultivated crops when artificially drained. It is susceptible to wetness. Runoff collects in depressions and requires surface drainage. Organic matter content is high in the Garwin soil and moderate to high in the Sperry soil. Capability unit IIw–3; environmental planting group 2.

Hayden series

The Hayden series consists of well drained soils on uplands. These soils formed in glacial till under deciduous forest. Slopes are 14 to 40 percent.

In a representative profile the surface layer is black loam about 2 inches thick. The subsurface layer is dark grayish brown loam about 7 inches thick. The subsoil extends to a depth of 41 inches; it is brown, yellowish brown, and grayish brown, friable to firm clay loam. The substratum is brown loam. Stones and pebbles are in the profile.

Permeability is moderate, and available water capacity is high. Available phosphorus in the subsoil is medium, and available potassium is low to very low.

The Hayden soils are mainly used for pasture. Some steep areas are in trees.

Representative profile of Hayden loam, 25 to 40 percent slopes, in a wooded area, 330 feet west and 660 feet north of the southeast corner of the NE¼ sec. 21, T. 81 N., R. 21 W.:

A1—0 to 2 inches; black (10YR 2/1) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A21—2 to 5 inches; dark grayish brown (10YR 4/2) loam, brown (10YR 4/3) crushed, light brownish gray (10YR 6/2) dry; weak thin platy structure; friable; slightly acid; gradual smooth boundary.

A22—5 to 9 inches; dark grayish brown (10YR 4/2) loam, grayish brown (10YR 5/2) crushed, light brownish gray (10YR 6/2) and light gray (10YR 7/2) dry; weak thin platy structure parting to weak fine granular; medium acid; clear wavy boundary.

B1t—9 to 21 inches; brown (10YR 4/3) light clay loam, yellowish brown (10YR 5/4) dry; moderate fine and medium angular and subangular blocky structure; friable; thin discontinuous light gray (10YR 7/2) silt coats on faces of peds; few patchy clay films; medium acid; gradual smooth boundary.

B2t—21 to 31 inches; yellowish brown (10YR 5/4) clay loam; few fine distinct strong brown (7.5YR 5/8) mottles; moderate fine and medium angular and subangular blocky structure; firm; thin discontinuous light brownish gray (10YR 6/2) silt coats and dark yellowish brown (10YR 4/4) clay films on faces of peds; slightly acid; gradual smooth boundary.

B3—31 to 41 inches; grayish brown (10YR 5/2) yellowish brown (10YR 5/4) clay loam; common fine distinct yellowish red (5YR 5/8) mottles; weak medium prismatic structure; friable; thin discontinuous light gray (10YR 7/2) silt coats and clay films on faces of peds; medium acid; clear wavy boundary.

C—41 to 60 inches; brown (10YR 5/3) loam; massive; friable; common coarse yellowish red (5YR 4/6) iron stains and dark-colored accumulations of oxides; slightly acid.

The solum is 36 to 55 inches thick. Depth to free carbonates ranges from 36 to 60 inches. The A1 horizon ranges from black (10YR 2/1) to very dark

grayish brown (10YR 3/2). It is 1 to 4 inches thick and is neutral or slightly acid. The A2 horizon is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2), 4 to 8 inches thick, and neutral to medium acid. The sand content of the B horizon ranges from 30 to 45 percent. The C horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/4). It is loam or clay loam and ranges from slightly acid to moderately alkaline.

The depth to free carbonates is greater than is defined in the range for the series. This does not have a significant effect on the use and behavior of the soils.

Hayden soils formed in the same kind of parent material as Lester and Clarion soils and are near those soils. Hayden soils have a thinner A1 horizon than Lester or Clarion soils. Hayden soils have an A2 horizon, which Clarion soils lack.

168E2—Hayden loam, 14 to 18 percent slopes, moderately eroded. This soil is on convex shoulders and side slopes adjacent to drainageways. Areas are irregular in shape and about 10 to 30 acres in size. Many of the areas on the shoulders of hills are long and narrow.

This soil has a profile similar to the one described as representative of the series, but erosion has removed most of the surface layer and exposed the dark grayish brown subsurface layer. In plowed areas, the surface and subsurface layers have been mixed with some of the brown subsoil. The plow layer is dark grayish brown.

Included with this soil in mapping are some areas of uneroded soils and a few areas of Lester soils. Also included are some areas of severely eroded soils, which are indicated by a special symbol on the soil map.

This soil is mainly used for hay and pasture. It is well suited to this use. It is susceptible to sheet and gully erosion. Organic matter content is low to very low. Capability unit IVe–1; environmental planting group 1.

168F—Hayden loam, 18 to 25 percent slopes. This soil is on convex side slopes adjacent to drainageways. Areas are typically long and narrow and range from about 10 to 30 acres in size.

Included with this soil in mapping are a few areas of Lester soils. Also included are some small areas that are severely eroded. These areas are indicated by a special symbol on the soil map.

Most areas of this soil are in pasture or timber, and the soil is well suited to these uses. It is susceptible to erosion, and gullies are common. Organic matter content is low. Capability unit VIe–1; environmental planting group 1.

168G—Hayden loam, 25 to 40 percent slopes. This soil is on long, irregular, convex side slopes that border drainageways. It is dissected by gullies and waterways. Areas range from about 10 acres to more than 60 acres in size.

This soil has the profile described as representative of the series. The brown subsoil is exposed in places. These areas are indicated on the soil map by a special erosion symbol for severe erosion.

Most areas of this soil are in trees or pasture. The soil is well suited to pasture, recreation and wildlife habitat. It is very susceptible to sheet and gully erosion. Organic matter content is low. Capability unit VIIe–1; environmental planting group 1.

Judson series

The Judson series consists of well drained to moderately well drained soils on alluvial fans and in narrow bands at the base of slopes. These soils formed under prairie grasses in silty local alluvium. Slopes are 0 to 9 percent.

In a representative profile the surface layer is black and very dark brown silty clay loam 24 inches thick. The subsoil extends to a depth of about 60 inches; it is very dark grayish brown and dark brown, friable silty clay loam in the upper part and yellowish brown, friable silty clay loam and silt loam in the lower part.

Permeability is moderate, and available water capacity is high. Available phosphorus and potassium are low in the subsoil.

Most areas are used for cultivated crops. Erosion is a hazard on the sloping soils. Excess water from upslope is a problem in places.

Representative profile of Judson silty clay loam, 2 to 5 percent slopes, in a cultivated field, 83 feet south and 166 feet east of northwest corner of the NE¼SW¼ sec. 6, T. 81 N., R. 19 W.:

Ap—0 to 6 inches; black (10YR 2/1) light silty clay loam, very dark brown (10YR 2/2) kneaded; weak fine granular structure; friable; slightly acid; gradual smooth boundary.

A12—6 to 11 inches; black (10YR 2/1) light silty clay loam, very dark brown (10YR 2/2) kneaded; weak fine granular structure; friable; slightly acid; gradual smooth boundary.

A13—11 to 18 inches; black (10YR 2/1) silty clay loam, very dark grayish brown (10YR 3/2) kneaded; weak and moderate fine and medium subangular blocky structure parting to weak fine granular; friable; slightly acid; gradual smooth boundary.

A14—18 to 24 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) kneaded; moderate fine and medium subangular blocky structure parting to weak fine and medium granular; friable; slightly acid; gradual smooth boundary.

B1—24 to 29 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark brown (10YR 3/3) kneaded; weak and moderate medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B21—29 to 35 inches; dark brown (10YR 3/3) silty clay loam; weak coarse prismatic structure parting to fine and medium subangular blocky; friable; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B22—35 to 44 inches; yellowish brown (10YR 5/4) light silty clay loam; weak coarse

prismatic structure parting to moderate medium subangular blocky; friable; thin discontinuous clay films; neutral; gradual smooth boundary.

B3—44 to 60 inches; yellowish brown (10YR 5/4) silt loam; weak medium coarse prismatic structure; friable; thin discontinuous light gray dry silt coats on faces of peds; neutral.

The solum ranges from 40 to 60 inches in thickness. These soils are black to very dark brown to a depth of 20 to 30 inches. In areas that have recent overwash, the plow layer is very dark grayish brown. The A horizon is heavy silt loam or light silty clay loam. The B2 and B3 horizons range from dark brown (10YR 3/3) to yellowish brown (10YR 5/4). Mottles generally are not present above a depth of 30 inches. The B1 and B2 horizons are light to medium silty clay loam. The B3 horizon ranges from medium silty clay loam to silt loam. Texture is silt loam or silty clay loam in the C horizon.

Judson soils are generally downslope from Tama and Otley soils. They have a thicker A horizon and a less strongly expressed B horizon than Tama and Otley soils, which formed in loess.

8—Judson silt loam, 0 to 2 percent slopes. This soil is on low stream benches. Most areas are large, up to 100 acres or more.

This soil has slightly less clay than the profile described as representative of the series.

Included with this soil in mapping are some areas of soils that are less well drained than this Judson soil. Also included are some low-lying areas that are subject to flooding during unusually high water. Some of these areas have lighter colored overwash on the surface.

This soil is used for cultivated crops. It is well suited to row crops and has no serious limitations. Organic matter content is high. Capability unit I–1; environmental planting group 1.

8B—Judson silty clay loam, 2 to 5 percent slopes. This soil is on convex alluvial fans and on long narrow areas on foot slopes. These areas range from 5 to 20 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Ely and Colo soils, which are more poorly drained than this Judson soil. Some areas have about 8 inches of silty overwash.

This soil is well suited to corn and soybeans, and these are the main crops. The soil generally is cropped with soils on adjacent benches and bottom lands. Erosion is a hazard. This soil receives excess water from adjoining soils upslope. This causes rilling and siltation. Organic matter content is high. Capability unit IIe–3; environmental planting group 1.

8C—Judson silty clay loam, 5 to 9 percent slopes. This soil is on long, narrow foot slopes. Areas are 5 to 15 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer is very dark grayish brown and is 20 to 26 inches thick.

Included with this soil in mapping are a few areas with 6 inches of recent deposition on the surface. In some places gullies dissect this unit.

This soil is moderately well suited to corn and soybeans, and these are the main crops. This soil receives excess water from upslope. The water causes sheet erosion, rilling and gullying, and siltation. Organic matter content is high. Capability unit IIIe–2; environmental planting group 1.

Kennebec series

The Kennebec series consists of moderately well drained soils on flood plains. These soils formed in silty alluvium under tall grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black silt loam about 34 inches thick. The substratum is black and very dark gray silty clay loam to a depth of 60 inches.

Permeability is moderate, and available water capacity is high. Available phosphorus in the subsoil is low, and available potassium is very low to low.

Kennebec soils are mainly used for row crops. Flooding is a major hazard, but in most places this is not a serious limitation for growing cultivated crops.

Representative profile of Kennebec silt loam, 0 to 2 percent slopes, in a pasture, 52 feet south and 680 feet west of the northeast corner of sec. 27, T. 80 N., R. 18 W.:

A11—0 to 9 inches; black (10YR 2/1) silt loam mixed with some very dark grayish brown (10YR 3/2) overwash; weak fine subangular blocky and moderate fine granular structure; friable; slightly acid; gradual smooth boundary.

A12—9 to 17 inches; black (10YR 2/1) silt loam; weak fine and medium subangular blocky structure parting to moderate fine granular; friable; slightly acid; diffuse smooth boundary.

A13—17 to 24 inches; black (10YR 2/1) silt loam; weak medium subangular blocky structure; friable; slightly acid; diffuse smooth boundary.

A14—24 to 34 inches; black (10YR 2/1) heavy silt loam; weak medium prismatic structure parting to weak medium subangular blocky; friable; slightly acid; gradual smooth boundary.

AC—34 to 50 inches; black (10YR 2/1) light silty clay loam; weak medium prismatic structure; friable; slightly acid; gradual smooth boundary.

C—50 to 60 inches; very dark gray (10YR 3/1) silty clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; weak medium prismatic structure; friable; neutral.

The solum ranges from 36 inches to more than 60 inches in thickness. The A1 horizon is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). The C horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). Clay content of the C horizon ranges from 24 to 30 percent.

Kennebec soils formed in parent material somewhat similar to that of Colo and Zook soils. They have less clay and are better drained than those soils.

212—Kennebec silt loam, 0 to 2 percent slopes. This soil is on flood plains near present river channels or adjacent to old stream channels. Areas are irregular in shape and range from 10 to 30 acres in size.

Included with this soil in mapping are more poorly drained soils in small concave areas and channels. These areas are indicated by a special symbol on the soil map. Small areas of Nodaway soils near stream channels and old meanders are also included. Also included are areas of soils that have as much as 15 inches of stratified overwash over the original surface layer.

This soil is well suited to corn and soybeans, and they are the main crops. Some areas are left in pasture. This soil is susceptible to occasional flooding. Organic matter content is high. Capability unit I–1; environmental planting group 1.

Killduff series

The Killduff series consists of moderately well drained soils on uplands. These soils formed mainly in mottled brownish and grayish loess under prairie grasses. Slopes are 5 to 18 percent.

In a representative profile the surface layer is black silty clay loam 7 inches thick. The upper part of the subsoil is brown, dark yellowish brown, yellowish brown, and grayish brown, friable silty clay loam, and the lower few inches is silt loam. A few mottles are at a depth of 19 inches, and their abundance increases with depth. The subsoil extends to a depth of 36 inches. The substratum is mottled grayish brown and yellowish brown silt loam to a depth of 60 inches.

Permeability is moderate, and available water capacity is high. Available phosphorus in the subsoil is low, and the available potassium is very low.

Killduff soils are mainly used for cultivated crops and hay. Erosion is the major hazard.

Representative profile of Killduff silty clay loam, 5 to 9 percent slopes, moderately eroded, in an alfalfa field, 450 feet south and 300 feet east of the northwest corner of sec. 20, T. 81 N., R. 19 W.:

Ap—0 to 7 inches; black (10YR 2/1) light silty clay loam; very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) crushed; weak fine granular structure; friable; neutral; abrupt smooth boundary.

B1—7 to 11 inches; brown (10YR 4/3) light silty clay loam; faces of some peds are very dark grayish brown (10YR 3/2); weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

B21—11 to 15 inches; brown (10YR 4/3) silty clay loam; faces of peds dark brown (10YR 3/3); weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

B22t—15 to 19 inches; dark yellowish brown (10YR 4/4) silty clay loam; faces of peds brown (10YR 4/3); weak fine and medium subangular blocky structure; friable; few thin discontinuous clay films; common fine dark-colored soft accumulations and concretions of oxides; slightly acid; gradual smooth boundary.

B23t—19 to 23 inches; dark yellowish brown (10YR 4/4) silty clay loam; faces of peds brown (10YR 4/3); few fine faint yellowish brown (10YR 5/6) and few fine distinct reddish brown (5YR 4/4) and yellowish red (5YR 4/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few thin discontinuous clay films; common fine dark-colored soft accumulations and concretions of oxides; slightly acid; gradual smooth boundary.

B24—23 to 31 inches; yellowish brown (10YR 5/4) light silty clay loam; faces of peds brown (10YR 4/3) and dark yellowish brown (10YR 4/4); common fine faint grayish brown (10YR 5/2) mottles in upper part of horizon and many in lower part; common fine faint yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) and distinct yellowish red (5YR 4/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; common fine dark-colored soft accumulations and concretions of oxides; neutral; gradual smooth boundary.

B3—31 to 36 inches; yellowish brown (10YR 5/4) and grayish brown (10YR 5/2) silt loam; common fine faint yellowish brown (10YR 5/6) and distinct strong brown (7.5YR 5/6) and yellowish red (5YR 4/6) mottles; weak medium prismatic structure; friable; common fine dark-colored soft accumulations and concretions of oxides; neutral; gradual smooth boundary.

C—36 to 60 inches; mottled grayish brown (10YR 5/2) and yellowish brown (10YR 5/4) silt loam; many fine distinct strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to massive; common fine dark-colored soft accumulations and concretions of oxides; neutral.

The solum is 30 to 55 inches thick. Carbonates are absent in the solum. The Ap or A1 horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) and is 6 to 9 inches thick. The B2 horizon is brown (10YR 4/3), dark yellowish brown (10YR 4/4), or yellowish brown (10YR 5/4). Mottling starts at a depth of about 15 or 20 inches and increases with depth. There are many grayish brown (10YR 5/2) mottles above a depth of 30 inches. In the B3 horizon it is hard to determine the matrix color because of the abundance of mottles. The grayish colors are associated with the relict deoxidized loess. The B3 and C horizons are silt loam or silty clay loam.

Killduff soils formed in the same kind of parent material as Tama soils. Killduff soils have mottles above a depth of 30 inches; Tama soils do not.

20C2—Killduff silty clay loam, 5 to 9 percent slopes, moderately eroded. This soil is on convex side slopes, typically on head slopes of drainageways. Areas are irregular in shape and range from 5 to 20 acres in size.

This soil has the profile described as representative of the series. In most plowed areas, material from the brown subsoil is mixed into the plow layer.

Included with this soil in mapping are areas of soils that are somewhat similar to Killduff soils but formed under trees and grass. Also included are small areas of Clarinda soils at the heads of drainageways. These areas are indicated by a special symbol on the soil map.

This soil is used for cultivated crops and hay. It is moderately well suited to row crops. Erosion is the main hazard. Organic matter content is moderate. Capability unit IIIe–1; environmental planting group 1.

20D2—Killduff silty clay loam, 9 to 14 percent slopes, moderately eroded. This soil is on convex side slopes. It is typically on head slopes of drainageways. Areas are irregular in shape and range from 5 to 25 acres in size.

This soil has a profile similar to the one described as representative of the series, but in plowed areas the surface layer is commonly mixed with the brown subsoil.

Included with this soil in mapping are areas of soils that are somewhat similar to Killduff soils but formed under trees and grass. Also included are small areas of severely eroded soils. These areas are indicated by a special symbol on the soil map. Also included are some areas of a soil that is calcareous at a depth of about 20 inches. These areas commonly are near the bases of slopes.

This soil is mainly used for cultivated crops and hay. It is moderately well suited to row crops if erosion is controlled. Organic matter content is moderate. Capability unit IIIe–3; environmental planting group 1.

20E2—Killduff silty clay loam, 14 to 18 percent slopes, moderately eroded. This soil is on convex side slopes. It is typically at the heads of drainageways. Areas are irregular in shape and 10 to 20 acres in size.

This soil has a profile similar to the one described as representative of the series, but in plowed areas the surface layer is mixed with some of the brown subsoil.

Included with this soil in mapping are areas of soils that are somewhat similar to Killduff soils but formed under trees and grass. Also included are areas of severely eroded soils, glacial till outcrops on small knolls, and areas of Clarinda soils in the heads of drainageways. These areas are indicated by a special symbol on the soil map. In places there are areas, near the base of the slope, of soils that are calcareous at a depth of about 20 inches.

This soil is mainly used for cultivated crops and hay. Some areas are in pasture. It is well suited to hay and pasture. Row crops can be grown occasionally if erosion is controlled. Organic matter content is moderate. Capability unit IVe–1; environmental planting group 1.

Ladoga series

The Ladoga series consists of moderately well drained soils on the uplands. These soils formed in loess under deciduous trees and tall prairie grasses. Slopes are 2 to 14 percent.

In a representative profile the surface layer is very dark grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown and grayish brown silt loam about 5 inches thick. The subsoil is brown, friable to firm silty clay loam that extends to a depth of 60 inches.

Permeability is moderately slow, and available water capacity is high. Available phosphorus in the subsoil is medium, and available potassium is very low.

Ladoga soils are mainly used for cultivated crops and pasture. Some areas are wooded. Erosion is the major hazard.

Representative profile of Ladoga silt loam, 2 to 5 percent slopes, in a cultivated field, 660 feet south and 600 feet west of the northeast corner of NW¼ sec. 33, T. 78 N., R. 21 W.:

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; neutral; clear smooth boundary.

A2—6 to 11 inches; dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) silt loam, grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) dry; moderate medium platy structure; friable; medium acid; abrupt smooth boundary.

B1t—11 to 17 inches; brown (10YR 4/3) light silty clay loam, brown (10YR 5/3) dry; dark grayish brown (10YR 4/2) faces of peds; weak fine subangular blocky structure; friable; thin discontinuous clay films and light gray dry silt coatings on faces of peds; neutral; gradual smooth boundary.

B21t—17 to 30 inches; brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; dark grayish brown (10YR 4/2) coats on faces of peds; moderate fine and medium subangular blocky structure; friable; thick continuous clay films; thin discontinuous light gray dry silt coatings on faces of peds; slightly acid; gradual smooth boundary.

B22t—30 to 42 inches; brown (10YR 5/3) heavy silty clay loam; dark yellowish brown (10YR 4/4) coatings on faces of peds; few fine distinct olive gray (5Y 5/2) and strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to weak fine and medium angular blocky; firm; thick continuous clay films; thin discontinuous light gray dry silt coatings on faces of peds; medium acid; gradual smooth boundary.

B23t—42 to 49 inches; brown (10YR 5/3) silty clay loam; common fine and medium distinct olive gray (5Y 5/2) and strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to weak medium angular blocky; firm; thin continuous clay films; thin discontinuous

light gray dry silt coatings on faces of peds; few fine dark-colored accumulations of oxides; medium acid; gradual smooth boundary.

B3t—49 to 60 inches; brown (10YR 5/3) light silty clay loam, pale brown (10YR 6/3) dry; common fine and medium distinct olive gray (5Y 5/2) and strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; thin discontinuous clay films; many fine dark-colored accumulations of oxides; medium acid.

The solum ranges from 36 to 72 inches in thickness. The Ap or A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is 6 to 10 inches thick. The A2 horizon is 2 to 6 inches thick. The B2 horizon is brown (10YR 4/3 or 5/3) or dark yellowish brown (10YR 4/4). It is 16 to 32 inches thick and is slightly acid to strongly acid. Soils that have an olive gray matrix below a depth of 36 inches are within the range for this series.

Ladoga soils formed in the same kind of parent material as Clinton and Otley soils. Ladoga soils have a thicker dark colored A1 horizon than Clinton soils. They have a thinner A1 horizon than Otley soils, and they have an A2 horizon, which Otley soils lack.

76B—Ladoga silt loam, 2 to 5 percent slopes. This soil is on convex ridgetops and shoulders of side slopes. Areas are long and narrow and range from about 10 to 50 acres in size.

This soil has the profile described as representative of the series.

This soil is mainly used for cultivated crops. It is well suited to row crops if erosion is controlled. Organic matter content is moderate. Capability unit IIe–2; environmental planting group 1.

76C2—Ladoga silt loam, 5 to 9 percent slopes, moderately eroded. This soil is on convex ridgetops and side slopes in the uplands. Areas are long, narrow, and irregular in shape and range from 10 to 50 acres in size.

This soil has a profile similar to the one described as representative of the series, but erosion has removed a portion of the surface layer. In plowed areas, the plow layer is very dark grayish brown and is mixed with some of the brown subsoil.

Included with this soil in mapping are small areas of severely eroded Ladoga soils. These areas are indicated by a special symbol on the soil map. Outcrops of red clay and glacial till are included in places, and these areas are also indicated by special symbols on the soil map.

This soil is mainly used for cultivated crops. It is moderately well suited to row crops if erosion is controlled. Organic matter content is moderate. Capability unit IIIe–1; environmental planting group 1.

76D2—Ladoga silt loam, 9 to 14 percent slopes, moderately eroded. This soil is on convex side slopes. Areas are long, narrow, and irregular in shape and generally range from 20 to 50 acres in size.

This soil has a profile similar to the one described as representative of the series, but erosion has removed a portion of the surface layer. In cultivated areas, the plow layer is a mixture of the original surface layer, the subsurface layer, and part of the brown subsoil. It is very dark grayish brown.

Included with this soil in mapping are small areas of severely eroded soils, small areas of glacial till outcrop, and areas of gray clay. These areas are indicated by special symbols on the soil map.

This soil is mainly used for cultivated crops, but some areas are in hay and pasture. It is moderately well suited to row crops if erosion is controlled. Organic matter content is moderate. Capability unit IIIe–3; environmental planting group 1.

Lamoni series

The Lamoni series consists of somewhat poorly drained soils on the uplands. These soils formed in weathered glacial till under grass. Slopes are 9 to 18 percent.

In a representative profile the surface layer is silty clay loam 10 inches thick; the upper 5 inches is very dark gray and the lower 5 inches is very dark grayish brown. The subsoil is grayish brown and light brownish gray, firm clay to a depth of 37 inches and light brownish gray, firm clay loam to a depth of 50 inches. The subsoil is mottled with yellowish brown and strong brown. The substratum is mottled light brownish gray clay loam to a depth of 60 inches.

Permeability is slow to very slow, and available water capacity is high to moderate. Available phosphorus in the subsoil is low, and available potassium is low to medium.

Lamoni soils are used for cultivated crops and for pasture. Erosion is the main hazard, but wetness is also a problem.

Representative profile of an uneroded Lamoni soil in an area of Lamoni silty clay loam, 14 to 18 percent slopes, moderately eroded, in a pasture, 825 feet south and 495 feet west of the northeast corner of SE¼ sec. 35, T. 81 N., R. 17 W.:

A1—0 to 5 inches; very dark gray (10YR 3/1) silty clay loam; moderate fine granular structure; friable, slightly acid; clear smooth boundary.

A3—5 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam; moderate fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

IIB1t—10 to 13 inches; grayish brown (2.5Y 5/2) light clay; moderate fine subangular blocky structure; firm; thin discontinuous clay films; slightly acid; gradual smooth boundary.

IIB21t—18 to 19 inches; grayish brown (2.5Y 5/2) light clay; few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; thin continuous clay films; slightly acid; gradual smooth boundary.

IIB22t—19 to 25 inches; light brownish gray (2.5Y 6/2) light clay; few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; thick continuous clay films;

some weatherable minerals; slightly acid; gradual smooth boundary.

IIB31—25 to 37 inches; grayish brown (2.5Y 5/2) light clay; few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; thin discontinuous clay films; slightly acid; gradual smooth boundary.

IIB32t—37 to 50 inches; light brownish gray (2.5Y 6/2) clay loam; many fine and medium prominent strong brown (7.5YR 5/8) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; firm; thin discontinuous clay films; neutral; gradual smooth boundary.

IIC—50 to 60 inches; light brownish gray (2.5Y 6/2) clay loam; common fine and medium prominent strong brown (7.5YR 5/8) mottles; massive; firm; neutral.

The solum ranges from 48 to 60 inches in thickness. The A horizon normally is silty clay loam but ranges to clay loam. The A1 or Ap horizon is black (10YR 2/1), very dark gray (10YR 3/1), very dark brown (10YR 2/2), or very dark grayish brown (10YR 3/2). The clay layer in the upper part of the B horizon ranges from 12 to 27 inches in thickness and contains 40 to 50 percent clay in the finest part. The content of sand and small pebbles increases with depth.

Lamoni soils in this county have colors higher in value in the upper part of the B horizon than is defined in the range for the series. This difference does not have a significant effect on the use and behavior of the soils.

Lamon. soils formed in the same kind of parent material a Clarinda, Adair, and Shelby soils. Lamoni soils contain more pebbles and stones and have a thinner and less clayey subsoil than Clarinda soils. Their subsoil is somewhat grayer and contains more clay than that of Shelby soils and is less red than that of Adair soils.

822D2—Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded. This soil occurs in narrow bands that extend along the contour of the land. Areas are about 10 to 20 acres in size.

This soil has a profile similar to the one described as representative of the series, but plowing and erosion have caused some grayish brown subsoil material to be mixed into the plow layer. In some places loamy sediments 10 to 20 inches thick are over the grayish clay subsoil. In a few inclusions the grayish clay is at a depth of about 3 feet, mainly at the heads of upland drainageways. A special symbol on the map indicates small areas of severe erosion. Narrow bands of Shelby soils are included in some places at the base of this unit.

In most areas this soil is managed along with adjoining soils. This soil is better suited to hay and pasture. Row crops can be grown occasionally if erosion is controlled. This soil normally has poor tilth and is difficult to work. This soil stays wet longer in spring and after rains than adjoining soils. As the soil drys, the surface layer becomes hard and cloddy and cracks extending into the subsoil appear. Seepage and surface wetness can be reduced by placing interceptor tile drains in the more permeable loess soils upslope. Tile lines do not function well in this soil. Organic matter content is moderate. Capability unit IVe–2; environmental planting group 1.

822E2—Lamoni silty clay loam, 14 to 18 percent slopes, moderately eroded. Areas of this soil are narrow bands extending along the contour of the land. They are about 10 to 20 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer is very dark grayish brown and has some grayish brown subsoil material mixed with it.

Included with this soil in mapping are small areas of Adair soils. Also included are soils that have as much as 3 feet of moderately fine textured material over the clayey subsoil.

In most areas this soil is managed along with adjoining soils. It is well suited to hay or pasture. Erosion is the main hazard. Wetness is also a hazard because water moves laterally from upslope, causing seep areas. This soil has poor tilth and is difficult to work. Organic matter content is moderate. Capability unit VIe–2; environmental planting group 1.

Lawler series

The Lawler series consists of somewhat poorly drained soils on stream benches. These soils formed in loamy alluvium overlying sand and gravel. The native vegetation was tall prairie grasses. Slope is 0 to 2 percent.

In a representative profile the surface layer is black loam in the upper part and very dark grayish brown loam in the lower part; it is 20 inches thick. The subsoil extends to a depth of 35 inches; the upper 10 inches is dark grayish brown, friable loam, and the lower 5 inches is dark yellowish brown and yellowish brown sandy clay loam. The substratum is strong brown and yellowish brown loamy sand to a depth of 60 inches.

Permeability is moderate in the surface layer and subsoil and rapid in the substratum. Available water capacity is moderate. Available phosphorus and potassium are very low in the subsoil.

Lawler soils are mainly used for row crops. Droughtiness is a hazard, especially where the depth to sand and gravel is less than about 2½ feet. On the deeper soils, it is less of a hazard but is a problem during prolonged dry periods.

Representative profile of Lawler loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes, in an area 660 feet south of the northwest corner of NE¼ SW¼ sec. 29, T. 81 N., R. 21 W.:

Ap—0 to 6 inches; black (10YR 2/1) loam; weak fine granular structure; friable; slightly acid; gradual smooth boundary.

A12—6 to 14 inches; black (10YR 2/1) loam; weak fine granular structure; friable; slightly acid; gradual smooth boundary.

A3—14 to 20 inches; very dark grayish brown (10YR 3/2) loam; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B21—20 to 24 inches; dark grayish brown (10YR 4/2) loam; few fine distinct yellowish

brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B22—24 to 30 inches; dark grayish brown (10YR 4/2) heavy loam; common fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; weak coarse and medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

B3—30 to 35 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) sandy clay loam; few fine faint light brownish gray (10YR 6/2) mottles; weak very coarse subangular blocky structure; friable; few dark-colored streaks of oxides; slightly acid; clear smooth boundary.

IIC1—35 to 40 inches; strong brown (7.5YR 5/6) loamy sand; few fine faint dark brown (7.5YR 4/4) mottles; single grained; loose; neutral; clear smooth boundary.

IIC2—40 to 60 inches; yellowish brown (10YR 5/6) loamy sand; few fine distinct light brownish gray (2.5Y 6/2) and faint strong brown (7.5YR 5/6) mottles; single grained; loose; neutral.

The solum is 24 to 40 inches thick. The A horizon ranges from 18 to 24 inches in thickness. The B2 horizon is mainly heavy loam but ranges from loam to light sandy clay loam. The IIB3 horizon is in some pedons. It formed in coarse material. The IIB3 or the IIC horizon ranges from loamy coarse sand to loamy medium gravel and includes thin layers of sandy loam.

Lawler soils formed in the same kind of parent material as the poorly drained Coland soils and the somewhat excessively drained Flagler soils. The sand and gravel substratum typical of Lawler soils is lacking or is below a depth of 40 inches in Coland soils. Lawler soils are finer textured in the upper part of the profile than Flagler soils.

225—Lawler loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. Many areas of this soil are at slightly higher elevations than the surrounding soils. Areas are typically about 15 acres in size.

This soil has a profile similar to the one described as representative of the series, but the depth to sand and gravel is less.

Included with this soil in mapping are some low lying areas that flood occasionally.

This soil is used for corn and soybeans and is managed with adjoining soils on the bottom lands. It is well suited to row crops. It is droughty, and unless rainfall is timely yields are restricted. Capability unit IIs–1; environmental planting group 1.

226—Lawler loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes. Most areas of this soil are 15 to 40 acres in size, but some are 100 acres or more. Many areas are elongated and are parallel to the streams.

This soil has the profile described as representative of the series.

Included with this soil in mapping are some soils on lower elevations than is typical for this Lawler soil. They are subject to occasional flooding.

This soil is well suited to row crops, and this is their main use. Some areas are large enough to be managed separately, but most are managed with adjoining soils. Droughtiness is a hazard during unusually long dry periods. Rare flooding occurs on some of the low lying areas. Capability unit IIs–1; environmental planting group 1.

Lester series

The Lester series consists of well drained soils on uplands. These soils formed in glacial till under prairie grasses and hardwood forest. Slopes are 2 to 14 percent.

In a representative profile the surface layer is black and very dark grayish brown loam about 7 inches thick. The subsurface layer is dark grayish brown loam about 3 inches thick. The subsoil is brown and yellowish brown, friable to firm clay loam and extends to a depth of 48 inches. The substratum is dark yellowish brown clay loam to a depth of 60 inches.

Permeability is moderate, and available water capacity is high. Available phosphorus in the subsoil is medium, and available potassium is very low.

Lester soils are mainly used for cultivated crops. Some areas are wooded or in pasture. Erosion is the major hazard.

Representative profile of Lester loam, 2 to 5 percent slopes, 150 feet west and 200 feet north of the southeast corner of sec. 2, T. 81 N., R. 21 W.:

A11—0 to 5 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) kneaded; weak fine granular structure; friable; neutral; clear smooth boundary.

A12—5 to 7 inches; very dark grayish brown (10YR 3/2) loam; grayish brown (10YR 5/2) dry; weak thin platy structure; friable; neutral; abrupt smooth boundary.

A2—7 to 10 inches; dark grayish brown (10YR 4/2) loam; light brownish gray (10YR 6/2) dry; weak thin platy structure parting to weak fine granular; friable; few light gray coats on faces of peds; slightly acid; clear wavy boundary.

B1—10 to 16 inches; brown (10YR 4/3) light clay loam, dark brown (10YR 3/3) kneaded; weak fine subangular blocky structure; friable; very dark grayish brown (10YR 3/2) coatings on peds; slightly acid; gradual smooth boundary.

B21t—16 to 24 inches; yellowish brown (10YR 5/4) clay loam; few fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; weak fine angular and subangular blocky structure; firm; brown (10YR 5/3) coatings on peds; slightly acid; gradual smooth boundary.

B22t—24 to 36 inches; yellowish brown (10YR 5/4) clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak fine angular and subangular blocky structure; friable; thin discontinuous clay films and many silt coats on faces of

peds; slightly acid; gradual smooth boundary.

B3—36 to 48 inches; yellowish brown (10YR 5/6) light clay loam; few fine distinct brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; thin discontinuous clay films and silt coats on faces of peds; slightly acid; gradual smooth boundary.

C—48 to 60 inches; dark yellowish brown (10YR 4/4) light clay loam; massive; friable; few grayish brown (10YR 5/2) coatings on faces of peds; slightly acid; gradual smooth boundary.

The thickness of the solum and depth to free carbonates range from 30 inches to more than 60 inches. The A1 horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) loam or light clay loam. It is 6 to 10 inches thick and when unlimed is medium or slightly acid in reaction. The A2 horizon is loam or light clay loam and is 2 to 6 inches thick. It is slightly acid or medium acid. The B2 horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4) and is heavy loam or light clay loam. It is slightly acid to strongly acid. The lower part of the B2 horizon in some profiles is neutral. The C horizon ranges from brown (10YR 4/3) to light olive brown (2.5Y 5/4). It is slightly acid to moderately alkaline.

Depth to free carbonates is greater than is defined in the range of the series, but this difference does not significantly affect the use and behavior of the soils.

Lester soils are near Hayden and Clarion soils and formed in the same kind of parent material. Lester soils have a thicker dark colored A horizon than Hayden soils. In unplowed areas, they have an A2 horizon which Clarion soils lack.

236B—Lester loam, 2 to 5 percent slopes. This soil is on convex side slopes on summits. Areas are irregular in shape and are 20 acres to more than 160 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of nearly level, somewhat poorly drained to poorly drained soils.

Most of this soil is used for cultivated crops. It is well suited to row crops. It is susceptible to sheet erosion. Organic matter content is low. Capability unit IIe–1; environmental planting group 1.

236C2—Lester loam, 5 to 9 percent slopes, moderately eroded. This soil is on convex side slopes and ends of ridgetops. Areas are irregular in shape and 15 acres to more than 40 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer has been eroded and the subsurface layer is exposed. The subsurface layer and some of the subsoil have been mixed with the surface layer in plowed areas.

Included with this soil in mapping are a few areas of severely eroded soils. These areas are indicated by a special symbol on the soil map.

This soil is mainly used for cultivated crops. It is moderately well suited to row crops but is susceptible to sheet erosion. Organic matter content is low. Capability unit IIIe–1; environmental planting group 1.

236D2—Lester loam, 9 to 14 percent slopes, moderately eroded. This soil is on convex side slopes. Some areas are dissected by waterways and gullies. Areas are irregular in shape and 10 to 40 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer has been removed by erosion and the subsurface layer is exposed. The subsurface layer and part of the subsoil have been mixed with the surface layer in plowed areas.

Included with this soil in mapping are a few small areas of Hayden soils. Areas of severely eroded soils are also included and are indicated by a special symbol on the soil map.

This soil is used for cultivated crops, hay, and pasture. A few areas are wooded. It is moderately well suited to row crops, but it is very susceptible to sheet and gully erosion. Organic matter content is low. Capability unit IIIe–3; environmental planting group 1.

Lindley series

The Lindley series consists of well drained to moderately well drained soils on uplands. These soils formed in clay loam glacial till under deciduous trees. Slopes are 14 to 40 percent.

In a representative profile the surface layer is very dark gray loam about 2 inches thick. The subsurface layer is very dark grayish brown and brown loam about 7 inches thick. The subsoil is brown friable loam in the upper part; dark yellowish brown and yellowish brown, firm clay loam in the middle part; and mottled grayish brown, brown, and yellowish brown, firm clay loam in the lower part to a depth of 43 inches. The substratum is mottled grayish brown and yellowish brown clay loam.

Permeability is moderately slow, and available water capacity is high. Available phosphorus in the subsoil is medium, and available potassium is very low.

Lindley soils are mainly used for pasture. Many areas are wooded. Erosion is the major hazard.

Representative profile of Lindley loam, 18 to 25 percent slopes, in a timbered pasture, at northwest corner of SW¼SE¼ sec. 14, T. 80 N., R. 17 W.:

A1—0 to 2 inches; very dark gray (10YR 3/1) loam; weak thin platy structure parting to weak fine granular; friable; slightly acid; abrupt smooth boundary.

A2—2 to 9 inches; brown (10YR 5/3) and very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) kneaded; weak thin platy structure; friable; thin discontinuous light brownish gray (10YR 6/2) dry silt coats; slightly acid; abrupt smooth boundary.

B1—9 to 13 inches; brown (10YR 4/3) loam; weak fine and medium subangular blocky structure; friable; thin discontinuous silt coats on faces of peds; medium acid; clear smooth boundary.

B21t—13 to 18 inches; dark yellowish brown (10YR 4/4) light clay loam; moderate fine and medium angular and subangular blocky structure; firm; thin discontinuous clay films and silt coats on faces of

peds; medium acid; clear smooth boundary.

B22t—18 to 29 inches; yellowish brown (10YR 5/6) clay loam; common fine distinct grayish brown (10YR 5/2) mottles; moderate fine and medium angular blocky structure; firm; thick continuous clay films and thin discontinuous silt coats on faces of peds; strongly acid; gradual smooth boundary.

B23t—29 to 38 inches; mottled grayish brown (10YR 5/2), brown (10YR 5/3), and yellowish brown (10YR 5/4) clay loam; few fine distinct strong brown (7.5YR 5/8) mottles; moderate medium angular blocky structure; firm; thick continuous clay films and thin discontinuous silt coats on faces of peds; strongly acid; gradual smooth boundary.

B3—38 to 43 inches; mottled grayish brown (10YR 5/2) and yellowish brown (10YR 5/4 and 5/6) clay loam; few fine distinct strong brown (7.5YR 5/8) mottles; moderate medium angular blocky structure; firm; thin continuous clay films and thin discontinuous silt coats on faces of peds; dark brown (10YR 3/3) coats and few fine black accumulations of oxides; strongly acid; gradual smooth boundary.

C—43 to 60 inches; mottled grayish brown (10YR 5/2) and yellowish brown (10YR 5/6 and 5/8) clay loam; few fine and medium strong brown (7.5YR 5/8) mottles; weak coarse prismatic structure; firm; thin discontinuous clay films and silt coats on faces of peds; few fine black accumulations of oxides; strongly acid.

The solum ranges from 30 to 50 inches in thickness. Pebbles and stones are generally throughout the profile. The A1 horizon ranges from very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2) and is loam, silt loam, or light clay loam. It is 1 to 4 inches thick and ranges from slightly acid to strongly acid. The A2 horizon ranges from brown (10YR 5/3) to dark grayish brown (10YR 4/2); some very dark grayish brown (10YR 3/2) is mixed in places. It is loam, silt loam, or light clay loam in texture. It is 2 to 7 inches thick and ranges from slightly acid to very strongly acid in reaction. The B2 horizon ranges from dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/6). The lower part commonly has mottles or mixing of material 10YR or 7.5YR in hue, 5 or 6 in value, and 2 to 8 in chroma. It is strongly acid or very strongly acid. The B3 horizon ranges from strongly acid to moderately alkaline.

Lindley soils formed in the same kind of parent material as Gara and Armstrong soils. Lindley soils have a thinner A1 horizon than Gara soils. They lack the reddish hues and have less clay than Armstrong soils.

65E—Lindley loam, 14 to 18 percent slopes. This soil is on convex side slopes in the uplands. Areas are long, narrow and irregular in shape and average 10 to 30 acres in size.

This soil has a profile similar to the one described as representative of the series. In cultivated areas, however, the plow layer is a mixture of the surface and subsurface layers and commonly the upper part of the subsoil.

Included with this soil in mapping are small areas of severely eroded soils, small areas of red clay or gray clay, and outcrops of shale. These areas are indicated by a special symbol on the soil map. Included in the vicinity of Carson Creek, southeast of Newton, are sandstone outcrops. These outcrops are indicated by a special symbol on the soil map.

Typical areas of this soil are in pasture. Many areas are wooded. This soil is poorly suited to cultivated crops and is well suited to hay, pasture, or woodland. It is susceptible to erosion. Organic matter content is low. Capability unit VIe–2; environmental planting group 1.

65F—Lindley loam, 18 to 25 percent slopes. This soil is on convex side slopes on uplands. Areas are long, narrow, and irregular in shape and average 5 to 25 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are steep, moderately eroded soils. Also included are small areas of severely eroded soils, small areas of red clay, and small areas of shale. These areas are indicated by special symbols on the soil map. Included in the vicinity of Carson Creek southeast of Newton are sandstone outcrops. These outcrops are indicated by a special symbol on the soil map.

This soil is not suited to cultivated crops, but is well suited to pasture and woodland. Most areas are wooded. Farm machinery or tree planting equipment can be used on many areas of this soil, although caution is necessary because of the steepness. If the trees are cleared, extreme care is needed to prevent the loss by erosion of the few inches of topsoil. This soil is very susceptible to erosion if vegetation is sparse. Organic matter content is low to very low. Capability unit VIIe–1; environmental planting group 1.

65G—Lindley loam, 25 to 40 percent slopes. This soil is on convex side slopes in the uplands. Areas are long, narrow, and irregular in shape and 10 to 40 acres in size.

Included with this soil in mapping are moderately eroded Lindley soils. Also included are small areas of severely eroded soils, small areas of red clay, and shale outcrops. These areas are indicated by special symbols on the soil map.

This soil is not suited to cultivated crops and is suited to woodland. Most areas are wooded. Many areas are grazed. Limiting grazing increases the production of wood products. This soil can be used for pasture. It is very susceptible to erosion if the trees are cleared. Organic matter content is low to very low. Capability unit VIIe–1; environmental planting group 1.

65E3—Lindley soils, 14 to 18 percent slopes, severely eroded. These soils are on convex side slopes on uplands. Areas are long, narrow, and irregular in shape and 5 to 20 acres in size.

Erosion has removed the original surface layer and at least part of the subsurface layer. The present surface layer is brown clay loam or loam.

Included with this soil in mapping are small areas

of red clay. These areas are indicated by a special symbol on the soil map. Some areas of steep Lindley soils are also included in mapping.

Lindley soils are poorly suited to cultivated crops and are well suited to pasture and woodland. These soils have been cleared of trees and generally are used for pasture. Brush and trees have grown back in the pasture in places. Farm machinery can be used on these soils, making it practical to fertilize and to renovate the pasture. Corn can be grown occasionally as the first step in renovation. Obtaining a good seedbed is difficult because of the poor structure of the exposed subsoil. These soils are very susceptible to erosion. Organic matter content is very low. Capability unit VIIe–1; environmental planting group 1.

Mahaska series

The Mahaska series consists of somewhat poorly drained soils on uplands. These soils formed in loess under prairie grass. Slope is 0 to 2 percent.

In a representative profile the surface layer is black silty clay loam about 22 inches thick. The subsoil extends to a depth of 60 inches. It is dark grayish brown, friable silty clay loam in the upper 9 inches and grayish brown, friable to firm silty clay loam in the lower part.

Permeability is moderately slow, and available water capacity is high. Available phosphorus is medium, and available potassium is very low in the subsoil.

Mahaska soils are used for cultivated crops. There are no serious limitations.

Representative profile of Mahaska silty clay loam, 0 to 2 percent slopes, in a cultivated field, 660 feet west and 165 feet south of the northeast corner of SE¼ SE¼ sec. 17, T. 78 N., R. 21 W.:

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam; moderate fine subangular blocky structure; friable; strongly acid; gradual smooth boundary.

A12—8 to 15 inches; black (10YR 2/1) silty clay loam; moderate fine subangular blocky structure; friable; strongly acid; gradual smooth boundary.

A3—15 to 22 inches; black (10YR 2/1) silty clay loam; moderate fine subangular blocky structure; friable; strongly acid; gradual smooth boundary.

B21t—22 to 31 inches; dark grayish brown (2.5Y 4/2) heavy silty clay loam; moderate fine subangular blocky structure; friable; few thin discontinuous very dark gray (10YR 3/1) clay films on faces of peds; strongly acid; gradual smooth boundary.

B22t—31 to 48 inches; grayish brown (2.5Y 5/2) silty clay loam; dark grayish brown (2.5Y 4/2) coats on faces of peds; few fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; firm; thick continuous clay films and thin discontinuous gray (10YR 7/2) dry silt coats; few fine soft dark colored accumulations of oxides; strongly acid; gradual smooth boundary.

B3t—48 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; weak medium prismatic structure; friable; thin continuous clay films; few fine soft dark-colored accumulations of oxides; medium acid.

The solum ranges from 48 inches to more than 60 inches in thickness. The A horizon is 14 to 24 inches thick. The A3 horizon is black (10YR 2/1) or very dark gray (10YR 3/1) and is 5 to 10 inches thick. The B21t horizon ranges from dark grayish brown (2.5Y 4/2) to olive brown (2.5Y 4/4). The B22t horizon ranges from dark grayish brown (2.5Y 4/2) or grayish brown (2.5Y 5/2) to olive gray (5Y 5/2). The olive gray colors generally occur only in the lower part. The B3t horizon is grayish brown (2.5Y 5/2) or olive gray (5Y 5/2). The maximum clay content in the most clayey part of the B horizon is less than 40 percent. Silt loam material occurs below a depth of 48 inches in places.

Mahaska soils are near Taintor and Otley soils and formed in the same kind of parent material. Mahaska soils are better drained than Taintor soils and lack the gleyed horizons below the A horizon typical of those soils. Mahaska soils have a thicker A horizon and grayer colors in the upper or middle part of the B horizon than Otley soils.

280—Mahaska silty clay loam, 0 to 2 percent slopes. This soil is on upland divides. Areas are long, wide, and irregular in shape and range from 10 acres to more than 100 acres in size.

Included with this soil in mapping are small areas of poorly drained or very poorly drained Taintor and Sperry soils. The Sperry soils are in small depressional areas and are indicated by a special symbol on the soil map.

This soil is mainly used for corn and soybeans. It is well suited to row crops. Tile drainage is used in places so that field operations can start sooner after rains. Care is needed to avoid working the soil when it is too wet. Organic matter content is high. Capability unit I–1; environmental planting group 1.

Marsh

354—Marsh. Marsh consists of low areas that remain wet or are under water most of the year. These areas are mainly on flood plains along major streams. Areas are usually less than 10 acres in size.

Marsh has no value for farming. These areas are difficult to drain. Plants that tolerate wetness grow in these areas. Marsh is well suited to wildlife habitat, and it is an excellent habitat for wetland wildlife species. Capability unit VIIw–1; not placed in an environmental planting group.

Martinsburg series

The Martinsburg series consists of well drained to moderately well drained soils. They are mainly on plane to slightly concave foot slopes and alluvial fans.

These soils formed in silty sediments washed from adjacent uplands. Native vegetation is trees. Slopes are 2 to 9 percent.

In a representative profile the surface layer is dark grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown and brown silt loam that extends to a depth of about 22 inches. The subsoil is brown, dark yellowish brown, and yellowish brown, friable silty clay loam that extends to a depth of 60 inches.

Permeability is moderate, and available water capacity is high. The available phosphorus in the subsoil is medium to high, and the available potassium is very low.

Martinsburg soils are mainly used for corn, small grain, soybeans, and legume hay. Runoff from adjacent slopes is the major hazard. These soils are wet for short periods of time.

Representative profile of Martinsburg silt loam, 2 to 5 percent slopes, 500 feet east and 210 feet south of the northwest corner of NE¼NW¼ sec. 32, T. 78 N., R. 21 W.:

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam; very dark grayish brown (10YR 3/2) coats on faces of peds; fine granular structure; very friable; medium acid; abrupt smooth boundary.

A21—6 to 16 inches; dark grayish brown (10YR 4/2) silt loam, dark grayish brown (10YR 4/2) kneaded; few fine faint yellowish brown (10YR 5/6) and light yellowish brown (10YR 6/4) mottles; moderate medium platy structure; very friable; many distinct silt coatings; medium acid; abrupt smooth boundary.

A22—16 to 22 inches; brown (10YR 4/3) silt loam, brown (10YR 5/3) kneaded; weak fine and medium subangular blocky structure; friable; thin discontinuous silt coatings; medium acid; gradual smooth boundary.

B21t—22 to 32 inches; brown (10YR 4/3) silty clay loam; moderate fine and medium subangular blocky structure; friable; thin discontinuous silt coats; thin discontinuous clay films; medium acid; gradual smooth boundary.

B22t—32 to 44 inches; yellowish brown (10YR 5/4 and 10YR 5/6) silty clay loam; strong coarse prismatic structure; friable; many distinct silt coatings; thin discontinuous clay films; medium acid; diffuse boundary.

B3—44 to 60 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) silty clay loam; few fine faint strong brown (7.5YR 5/8) mottles; weak coarse prismatic structure; friable; many distinct silt coats; thick continuous clay films; medium acid.

The A1 or Ap horizon ranges from 6 to 8 inches in thickness. The A2 horizon is brown (10YR 4/3 or 5/3), dark grayish brown (10YR 4/2), or grayish brown (10YR 5/2) and ranges from 10 to 16 inches in thickness. The B horizon is dark grayish brown (10YR 4/2) to yellowish brown (10YR 5/6). Depth to the B horizon ranges from 16 to 24 inches. Grayish mottles are in the lower part of the solum in places.

Martinsburg soils formed in the same kind of parent materials as Judson soils, but they have a lighter colored, thinner surface layer than those soils.

742B—Martinsburg silt loam, 2 to 5 percent slopes. This soil is on plane to slightly concave foot slopes. Areas are typically in drainageways and on alluvial fans. They are commonly long and narrow or fan-shaped and are about 5 to 10 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Ackmore and Colo soils, which are more poorly drained than this soil.

Nearly all areas of this soil are cultivated. They are generally farmed with soils of the bottom lands, rather than with the more sloping upland soils. This soil is well suited to row crops. Excess water from soils upslope runs across this soil and causes rilling and gullying, siltation, and wetness. Organic matter content is low. Capability unit IIe–3; environmental planting group 1.

742C—Martinsburg silt loam, 5 to 9 percent slopes. This soil is in narrow drainageways and on alluvial fans. Areas are 5 to 10 acres in size.

Included with this soil in mapping are some gently sloping Martinsburg soils and some areas of Ackmore and Colo soils, which are more poorly drained than this soil.

Nearly all areas of this soil are cultivated. It is moderately well suited to row crops. Excess water from soils upslope runs across this soil causing sheet and gully erosion and siltation. Organic matter content is low. Capability unit IIIe–2; environmental planting group 1.

Muscatine series

The Muscatine series consists of somewhat poorly drained soils on uplands and high stream benches. These soils formed in thick deposits of loess under tall prairie grasses. Slopes are 0 to 2 percent.

In a representative profile (fig. 11) the surface layer is black silty clay loam about 18 inches thick. The subsoil is friable silty clay loam and extends to a depth of 47 inches. The upper 5 inches is very dark grayish brown, and the rest is dark grayish brown and grayish brown. The substratum is olive gray and light brownish gray silty clay loam to a depth of 72 inches.

Permeability is moderate, and available water capacity is high. Available phosphorus in the subsoil is low, and available potassium is very low.

Muscatine soils are mainly used for cultivated crops. The soils have no serious limitations.

Representative profile of Muscatine silty clay loam, 0 to 2 percent slopes, in a pasture, 600 feet north and 660 feet west of the southeast corner of NE¼SE¼ sec. 11, T. 81 N., R. 17 W.:

A1—0 to 18 inches; black (10YR 2/1) silty clay loam; weak and moderate fine granular structure; friable; medium acid; gradual smooth boundary.

B1—18 to 23 inches; very dark grayish brown

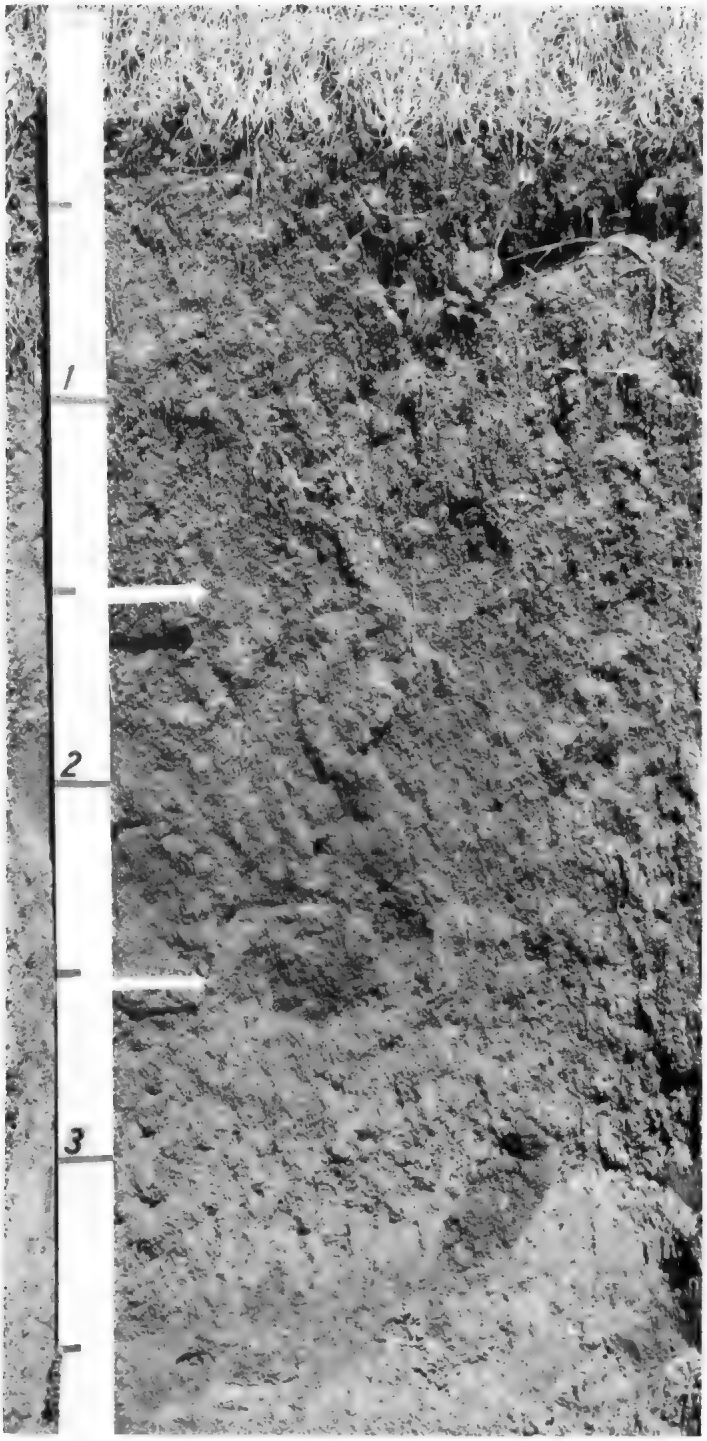

Figure 11.—**Profile of a Muscatine silty clay loam. The thick, dark-colored surface layer is typical of this soil.**

(10YR 3/2) silty clay loam; moderate fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B21t—23 to 31 inches; dark grayish brown (10YR 4/2) silty clay loam, crushes to olive brown (2.5Y 4/4); moderate fine and medium subangular blocky structure; friable; thin continuous clay films; medium acid; gradual smooth boundary.

B22t—31 to 38 inches; dark grayish brown (2.5Y 4/2) silty clay loam, crushes to olive brown (2.5Y 4/4); few fine distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/8) mottles; weak fine and medium subangular blocky structure; friable; thin discontinuous clay films; medium acid; gradual smooth boundary.

B3—38 to 47 inches; grayish brown (2.5Y 5/2) silty clay loam, crushes to olive brown (2.5Y 4/4); few fine faint grayish brown (10YR 5/2) and distinct yellowish brown (10YR 5/8) mottles; weak medium prismatic structure; friable; thin discontinuous clay films; few dark colored accumulations of oxides; slightly acid; gradual smooth boundary.

C—47 to 72 inches; olive gray (5Y 5/2) and light brownish gray (2.5Y 6/2) silty clay loam; common fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; few dark-colored accumulations of oxides; slightly acid.

The solum ranges from 40 to 60 inches in thickness. The A horizon is light silty clay loam or medium silty clay loam. It is 16 to 20 inches thick and is medium acid or strongly acid. The B horizon is medium acid or strongly acid in the upper part. It is 28 to 40 inches thick.

Muscatine soils are near Tama and Garwin soils and formed in the same kind of parent material. Muscatine soils are less gray in the subsoil than Garwin soils and are grayer than Tama soils.

119—Muscatine silty clay loam, 0 to 2 percent slopes. This soil is typically on moderately wide upland ridges and broad divides. A few areas are on stream benches. Areas are 10 acres to more than 100 acres in size.

Included with this soil in mapping are small areas of Garwin or Sperry soils in swales or depressions. These soils are more poorly drained than this soil.

This soil is mainly used for corn and soybeans, and it is well suited to their use. Surface runoff is slow, and this soil is wet for short periods. Surface drainage or tile is used in places. Organic matter content is high. Capability unit I–1; environmental planting group 1.

Mystic series

The Mystic series consists of moderately well drained to somewhat poorly drained soils that are mainly on remnants of high stream benches. These soils formed in water-sorted glacial sediments under mixed grass and forest. Slopes are 9 to 18 percent.

In a representative profile the surface layer is very dark grayish brown and dark brown clay loam about 6 inches thick. The subsoil extends to a depth of 41 inches; the upper 13 inches is yellowish red, friable clay loam, and the lower part is mainly yellowish brown, firm clay loam. Red, yellowish red, and strong brown mottles are common. The substratum is mottled

yellowish brown and yellowish red clay loam to a depth of 60 inches.

Permeability is slow, and available water capacity is high. Available phosphorus and potassium are very low in the subsoil.

Mystic soils usually are in hay and pasture. Erosion is the major hazard.

In this county Mystic soils are mapped only in undifferentiated groups with Caleb soils.

Representative profile of Mystic clay loam in an area of Caleb and Mystic soils, 14 to 18 percent slopes, moderately eroded, in a pasture, 660 feet south and 50 feet west of northeast corner of NW¼ sec. 21, T. 80 N., R. 19 W.:

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) light clay loam, very dark grayish brown (10YR 3/2) kneaded; weak fine and medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

B1—6 to 11 inches; yellowish red (5YR 4/6) clay loam; brown (7.5YR 5/2) coats on faces of peds; few dark brown (7.5YR 3/2) worm coats; weak fine and medium subangular blocky structure; friable; few discontinuous silt coats on faces of peds; medium acid; clear smooth boundary.

B21t—11 to 19 inches; yellowish red (5YR 4/8) clay loam; brown (7.5YR 5/2) coats on faces of peds; few fine faint red (2.5YR 4/8) mottles; weak medium subangular blocky structure; friable; few discontinuous silt coats on faces of peds; thin discontinuous clay films; medium acid; clear smooth boundary.

B22t—19 to 29 inches; mottled yellowish brown (10YR 5/6 and 5/8), brownish yellow (10YR 6/6), and grayish brown (10YR 5/2) clay loam; common fine and medium prominent yellowish red (5YR 5/8) and red (2.5YR 4/8) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; firm; few thin discontinuous clay films; silt coats on the faces of peds; medium acid; gradual smooth boundary.

B31t—29 to 36 inches; mottled yellowish brown (10YR 5/6 and 5/8) and brownish gray (10YR 5/2) clay loam; few fine faint strong brown (7.5YR 5/8) and common fine prominent yellowish red (5YR 4/8) mottles; weak coarse prismatic structure; firm; thick continuous clay films on root channels; silt coats on faces of peds; few dark brown (7.5YR 4/4) filled channels; medium acid; gradual smooth boundary.

B32—36 to 41 inches; mottled yellowish brown (10YR 5/4, 5/6, and 5/8) clay loam; common fine and medium distinct red (2.5YR 4/8) mottles; weak coarse prismatic structure; firm; thick continuous clay films on root channels; silt coats on faces of peds; medium acid; gradual smooth boundary.

C—41 to 60 inches; mottled yellowish brown (10YR 5/4, 5/6, and 5/8) clay loam; few fine distinct yellowish red (5YR 4/8) mottles; massive with vertical cleavage; firm; thick continuous very dark brown (10YR 3/2) clay films and grayish brown (10YR 5/2) silt coats on cleavage breaks; few fine dark reddish brown (5YR 3/2 and 2/2) accumulations of oxides; slightly acid.

The solum is more than 40 inches thick. The Ap horizon is very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2), or dark brown (10YR 3/3). The A horizon is loam, silt loam, or clay loam. In uneroded areas there is an A2 horizon. The combined thickness of the A1 and A2 horizons is 8 to 16 inches. The upper part of the B horizon is reddish brown (5YR 4/4) or yellowish red (5YR 4/6) loam or clay loam. This grades into mottled yellowish brown (10YR 5/6 and 5/8), yellowish red (5YR 4/8), red (2.5YR 4/8), and brown (10YR 5/3) with depth. The range in texture of the lower part of the B horizon and in the C horizon is sandy loam, loam, and clay loam.

The upper part of the B horizon lacks mottles with chroma of 2 or less. This is outside the range of the Mystic series, but it does not significantly affect the use and behavior of this soil.

Mystic soils adjoin Caleb soils, which lack the reddish colors typical of Mystic soils. They are similar to Armstrong soils in color but formed in coarser textured, more variable parent material than Armstrong soils.

Nevin series

The Nevin series consists of somewhat poorly drained soils on stream benches or second bottoms. These soils formed in silty alluvium. Native vegetation was prairie grasses. Slope is 0 to 2 percent.

In a representative profile the surface layer is black and very dark gray silty clay loam that extends to a depth of 22 inches. The subsoil is friable silty clay loam that extends to a depth of 53 inches; it is dark grayish brown in the upper part and grayish brown in the lower part. The substratum is mottled grayish brown silty clay loam.

Permeability is moderate to moderately slow, and available water capacity is high. Available phosphorus is medium, and available potassium is high in the subsoil.

Nevin soils are mainly used for corn and soybeans. They have no serious limitations.

Representative profile of Nevin silty clay loam, 0 to 2 percent slopes, in a cultivated field, 1,480 feet south and 1,560 feet east of the northwest corner of sec. 19, T. 79 N., R. 19 W.:

Ap—0 to 7 inches; black (10YR 2/1) light silty clay loam; weak fine granular structure; friable; slightly acid; gradual smooth boundary.

A12—7 to 12 inches; black (10YR 2/1) light silty

clay loam; weak fine granular and weak very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A13—12 to 18 inches; very dark gray (10YR 3/1) light silty clay loam; weak fine granular and weak very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A3—18 to 22 inches; very dark gray (10YR 3/1) medium silty clay loam; weak very fine and fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

B1—22 to 26 inches; dark grayish brown (10YR 4/2) medium silty clay loam; very dark grayish brown (10YR 3/2) coats on faces of peds; few fine distinct yellowish brown (10YR 5/4) mottles; weak moderate fine subangular blocky structure; friable; few patchy silt coats; slightly acid; gradual smooth boundary.

B21t—26 to 34 inches; dark grayish brown (10YR 4/2) medium silty clay loam; very dark grayish brown (10YR 3/2) coats on faces of peds; common medium distinct yellowish brown (10YR 5/4 and 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; thin discontinuous clay films; thick patchy silt coats; slightly acid; gradual smooth boundary.

B22t—34 to 42 inches; dark grayish brown (10YR 4/2) medium silty clay loam; common fine and medium distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; thin discontinuous clay films; few patchy silt coats; neutral; gradual smooth boundary.

B3—42 to 53 inches; grayish brown (2.5Y 5/2) light silty clay loam; many medium distinct yellowish brown (10YR 5/6 and 5/8) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; thin discontinuous clay films on root channels; few patchy silt coats; neutral; gradual smooth boundary.

C—53 to 60 inches; grayish brown (2.5Y 5/2) light silty clay loam; many medium distinct yellowish brown (10YR 5/6 and 5/8) mottles; massive; friable; few dark-colored accumulations of oxides; neutral.

The solum ranges from 36 to 60 inches in thickness. Carbonates are absent. In some profiles the A3 horizon is very dark grayish brown (10YR 3/2). The A horizon is light silty clay loam or medium silty clay loam. It is medium acid or slightly acid. The B horizon has a range in clay content of about 32 to 36 percent.

In this county the mollic epipedon is thinner than is defined in the range for the Nevin series. This does not significantly affect the use or behavior of these soils.

Nevin soils are near Bremer, Wiota, and Zook soils. Nevin soils are on lower positions and lack the brown B horizon characteristic of the well drained or moderately well drained Wiota soils. They are less clayey than and lack the gray colors of the poorly drained Zook and Bremer soils, which are at lower elevations.

88—Nevin silty clay loam, 0 to 2 percent slopes. This soil is on stream benches or second bottoms. Areas are irregular in shape and about 10 to 60 acres in size.

Included with this soil in mapping are small areas of sandy soils and small depressions that are indicated by special symbols on the soil map.

This soil is well suited to row crops. Corn and soybeans are the main crops. This soil has no serious limitations. Tile systems have been installed in a few places to speed drying of the soil. Organic matter content is high. Capability unit I–1; environmental planting group 1.

Nicollet series

The Nicollet series consists of somewhat poorly drained soils on uplands. These soils formed in till or till-derived material under native grass. Slopes are 1 to 3 percent.

In a representative profile the surface layer is black and is 18 inches thick; it is loam in the upper part and clay loam in the lower part. The subsoil is friable clay loam that extends to a depth of 37 inches; it is very dark grayish brown in the upper part, dark grayish brown in the middle part, and olive brown in the lower part. The substratum is grayish brown, light olive brown, and olive yellow loam.

Permeability is moderate, and available water capacity is high. Available phosphorus in the subsoil is very low, and available potassium is very low to low.

Nicollet soils are used mainly for row crops. When the soils are plowed in fall, soil blowing is a hazard.

Representative profile of Nicollet loam, 1 to 3 percent slopes, in a cultivated field, 180 feet south and 80 feet east of the northwest corner of NE¼ sec. 3, T. 81 N., R. 21 W.:

Ap—0 to 7 inches; black (10YR 2/1) loam; weak fine granular structure; friable; medium acid; gradual smooth boundary.

A12—7 to 13 inches; black (10YR 2/1) loam; weak and moderate fine and very fine granular structure; friable; slightly acid; gradual smooth boundary.

A3—13 to 18 inches; black (10YR 2/1) clay loam; weak fine angular and subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B1—18 to 23 inches; very dark grayish brown (2.5Y 3/2) clay loam, dark grayish brown (2.5Y 4/2) kneaded; weak fine subangular blocky structure; friable; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B2—23 to 33 inches; dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) clay loam; few fine faint light yellowish

brown (2.5Y 6/4) mottles; weak fine subangular blocky structure; friable; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B3—33 to 37 inches; olive brown (2.5Y 4/4) clay loam; few fine faint light yellowish brown (2.5Y 6/4) mottles; weak and moderate fine and medium subangular blocky structure; friable; thin discontinuous clay films; slightly acid; clear wavy boundary.

C1—37 to 45 inches; grayish brown (2.5Y 5/2) loam; common fine distinct light yellowish brown (2.5Y 6/4) and light olive brown (2.5Y 5/6) mottles; massive; friable; neutral; gradual smooth boundary.

C2—45 to 72 inches; mottled grayish brown (2.5Y 5/2), light olive brown (2.5Y 5/4), and olive yellow (2.5Y 6/6) loam; few fine prominent dark brown and red mottles; massive; friable; strongly effervescent; mildly alkaline.

The thickness of the solum and depth to free carbonates range from 20 to 48 inches. Coarse fragments are dispersed throughout the matrix. The A horizon is typically black (10YR 2/1) or very dark gray (10YR 3/1). Texture of the A horizon is typically loam but ranges to clay loam. The B2 horizon ranges from loam to clay loam.

Nicollet soils are near Clarion and Webster soils and formed in the same kind of parent material. Nicollet soils have a thicker A horizon than Clarion soils. Nicollet soils are somewhat poorly drained, Clarion soils are well drained, and Webster soils are poorly drained.

55—Nicollet loam, 1 to 3 percent slopes. This soil has slopes that are smooth or slightly convex. Areas are typically 5 to 30 acres in size.

Included with this soil in mapping are small areas, less than 2 acres in size, of poorly drained depressional soils. These areas are indicated by a special symbol on the soil map.

This soil is mainly used for corn and soybeans. It is well suited to row crops. It has no serious limitations. Soil blowing is a problem in some years, especially if the soil is plowed in the fall. In wet years some areas adjacent to poorly drained Webster and Canisteo soils are too wet for good growth of plants. Tile drains benefit these areas. Capability unit I–1; environmental planting group 1.

Nira series

The Nira series consists of moderately well drained soils on uplands. The soils formed in loess under prairie grasses. Slopes are 2 to 14 percent.

In a representative profile the surface layer is very dark gray silty clay loam about 8 inches thick. The subsoil is friable silty clay loam that extends to a depth of 42 inches; the upper part is brown and grayish brown, and the lower part is grayish brown and has many mottles. The substratum is gray silt loam that has many mottles and extends to a depth of 60 inches.

Permeability is moderately slow, and available water holding capacity is high. Available phosphorus and potassium are very low in the subsoil.

Nira soils are mainly used for cultivated crops. Erosion is the major hazard.

Representative profile of Nira silty clay loam, 5 to 9 percent slopes, moderately eroded, in a cultivated field on southeast-facing slope, 750 feet north and 474 feet east of the southeast corner of the SE¼SW¼ sec. 36, T. 78 N., R. 17 W.:

Ap—0 to 8 inches; very dark gray (10YR 3/1) silty clay loam mixed with brown (10YR 4/3); weak very fine granular structure; friable; slightly acid; abrupt smooth boundary.

B21t—8 to 18 inches; brown (10YR 4/3) and grayish brown (10YR 5/2) silty clay loam; very dark grayish brown (10YR 3/2) and dark grayish brown (10YR 4/2) coats on faces of peds; few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; thin discontinuous clay films; few fine distinct dark colored accumulations of oxides; slightly acid; gradual smooth boundary.

B22t—18 to 32 inches; grayish brown (2.5Y 5/2) silty clay loam; few fine prominent yellowish red (7.5YR 4/6) mottles; weak coarse and medium prismatic structure parting to moderate medium subangular blocky; friable; thin discontinuous clay films on faces of peds; neutral; gradual smooth boundary.

B3t—32 to 42 inches; grayish brown (2.5Y 5/2) light silty clay loam; many fine prominent yellowish brown (10YR 5/8) and yellowish red (5YR 4/6) mottles; weak coarse prismatic structure; friable; thin discontinuous clay films; neutral; gradual smooth boundary.

C—42 to 60 inches; gray (5Y 6/1) silt loam; common fine and medium prominent yellowish brown (10YR 5/8) and yellowish red (5YR 4/6) mottles; massive; friable; mildly alkaline.

The solum ranges from 30 to 50 inches in thickness. The A horizon is black (10YR 2/1), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). The B21t horizon ranges from 6 to 12 inches in thickness. Depth to the grayish brown (2.5Y 5/2) layer is 12 to 20 inches.

In most places the surface layer is thinner or lighter colored than is defined in the range for the Nira series, but this does not alter their usefulness or behavior.

Nira soils are near Mahaska and Otley soils and formed in the same kind of parent material. Nira soils are browner in the upper part of the B horizon than Mahaska soils and grayer in the lower part of the B horizon than Otley soils.

570B2—Nira silty clay loam, 2 to 5 percent slopes, moderately eroded. This soil is on convex side slopes, typically at the heads of drainageways. Areas are irregular in shape and from 5 to 20 acres in size.

Included with this soil in mapping are some areas

of uneroded Nira soils. These soils have a black surface layer about 10 inches thick. Some gray, clayey soils are also included. These soils are indicated by a special symbol on the soil map. These clayey soils cause seepy areas to develop.

Most areas are in cultivated crops. This soil is well suited to row crops. Erosion is the main hazard. Organic matter content is moderate. Capability unit IIe–2; environmental planting group 1.

570C2—Nira silty clay loam, 5 to 9 percent slopes, moderately eroded. This soil is on convex side slopes at the heads of drainageways. Areas are irregular in shape and 5 to 20 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of severely eroded soils and areas of gray clay. These areas are indicated by special symbols on the soil map.

This soil is used for cultivated crops. It is moderately well suited to row crops. Erosion is the main hazard. Organic matter content is moderate. Capability unit IIIe–1; environmental planting group 1.

570D2—Nira silty clay loam, 9 to 14 percent slopes, moderately eroded. This soil is on convex side slopes that border the heads of drainageways. Areas are irregular in shape and 10 to 25 acres in size.

Included with this soil in mapping are areas of severely eroded soils and small areas of gray clayey soils. These areas are indicated by special symbols on the soil map.

This soil is used for cultivated crops and hay. It is moderately well suited to row crops. It is susceptible to erosion. Organic matter content is moderate. Capability unit IIIe–3; environmental planting group 1.

Nodaway series

The Nodaway series consists of moderately well drained soils on bottom lands. These soils formed in recently deposited silty alluvium under tall prairie grasses and timber. Slope is 0 to 2 percent.

In a representative profile the surface layer is very dark grayish brown and black silt loam 9 inches thick; it contains a few, thin, grayish brown strata. It is underlain by stratified grayish brown, dark grayish brown, very dark grayish brown, and black, friable silt loam to a depth of 60 inches.

Permeability is moderate, and available water capacity is high. Available phosphorus and potassium are medium in the subsoil.

Nodaway soils are mainly used for row crops. Some areas are wooded. Flooding is the major hazard.

Representative profile of Nodaway silt loam, 0 to 2 percent slopes, in a pasture, 1,485 feet south and 825 feet west of the northeast corner of sec. 5, T. 81 N., R. 20 W.:

A1—0 to 9 inches; stratified very dark grayish brown (10YR 3/2) and black (10YR 2/1) silt loam; few thin grayish brown (10YR 5/2) strata; weak fine granular structure; friable; neutral; gradual smooth boundary.

C—9 to 60 inches; stratified very dark grayish brown (10YR 3/2), grayish brown (10YR 5/2), dark grayish brown loam; few thin strata of light silty clay loam; massive; friable; neutral.

The A horizon is neutral or slightly acid. The Ap or A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). The C horizon is stratified with colors that range from black (10YR 2/1) to grayish brown (10YR 5/2). The C horizon is silt loam with a few thin lenses of coarser texture and a few thin strata of silty clay loam. The C horizon is neutral or slightly acid. A dark-colored buried soil occurs below a depth of 40 inches in some places.

Nodaway soils formed in parent material similar to that in which Kennebec and Ackmore soils formed. Nodaway soils have a thinner A horizon than Kennebec soils. They are stratified to a depth of more than 40 inches, but Ackworth soils have a buried soil between depths of 20 and 40 inches.

220—Nodaway silt loam, 0 to 2 percent slopes. This soil is on first bottoms adjacent to streams and on alluvial fans. Areas are long and moderately wide. They are parallel to the stream channel and are 10 to 80 acres in size. In areas where the stream has been straightened, this soil is along the old channel.

Included with this soil in mapping are small areas of Ackmore and Colo soils, which are less well drained than Nodaway soil. Also included are small areas of concave soils that are wet. These areas are indicated by a special symbol on the soil map.

This soil is mostly used for corn and soybeans, but a few areas have not been cleared of trees. Other areas are left in pasture because of the flooding hazard. This soil is well suited to intensive row cropping. It is susceptible to occasional flooding, but areas seldom remain too wet to produce crops. Organic matter content is low to moderate. Capability unit IIw–2; environmental planting group 1.

Olmitz series

The Olmitz series consists of well drained to moderately well drained soils on foot slopes. These soils formed in loamy material that washed from adjoining slopes. Native vegetation is prairie grasses. Slopes are 2 to 9 percent.

In a representative profile the surface layer is black and very dark gray loam about 24 inches thick. The subsoil extends to a depth of 53 inches; it is very dark grayish brown, friable clay loam in the upper 8 inches and brown, friable clay loam in the lower part. The substratum is yellowish brown clay loam that is mottled.

Permeability is moderate, and available water capacity is high. Available phosphorus and potassium are very low in the subsoil.

Olmitz soils are farmed with adjacent bottom land soils and are mainly used for row crops. Erosion is the major hazard.

Representative profile of Olmitz loam, 2 to 5 percent slopes, in a hayfield, 330 feet east and 495 feet north of the southwest of corner sec. 24, T. 79 N., R. 21 W.:

Ap—0 to 8 inches; black (10YR 2/1) loam; moderate fine granular structure; friable; slightly acid; gradual smooth boundary.

A12—8 to 15 inches; very dark gray (10YR 3/1) loam; moderate fine granular structure;

friable; medium acid; gradual smooth boundary.

A13—15 to 24 inches; very dark gray (10YR 3/1) loam; weak fine subangular blocky structure; friable; thin discontinuous silt coats on faces of peds; medium acid; smooth gradual boundary.

B1—24 to 32 inches; very dark grayish brown (10YR 3/2); light clay loam; weak fine and medium subangular blocky structure; friable; medium acid; gradual smooth boundary.

B21—32 to 40 inches; brown (10YR 4/3) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; friable; medium acid; gradual smooth boundary.

B22—40 to 53 inches; brown (10YR 4/3) clay loam; few medium distinct strong brown (7.5YR 5/6) and few fine faint yellowish brown (10YR 5/6) and grayish brown (10YR 5/2) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; friable; medium acid; gradual smooth boundary.

C—53 to 60 inches; yellowish brown (10YR 5/4 and 5/6) light clay loam; common medium distinct strong brown (7.5YR 5/6) and few fine faint grayish brown (10YR 5/2) mottles; massive; friable; medium acid.

The solum is typically more than 40 inches thick. The Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The A12 and A13 horizons are black (10YR 2/1), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). Recently deposited overwash as much as 12 inches thick is on the surface in some places. It is commonly very dark grayish brown (10YR 3/2). The A horizon is loam or light clay loam. The B1 horizon is dark brown (10YR 3/3) to very dark grayish brown (10YR 3/2) loam or clay loam. The B2 horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/4). Clay loam glacial till is at a depth of 40 to 60 inches in some places.

Olmitz soils formed in material eroded from the side slopes where Shelby and Gara soils formed. They have a thicker A horizon and a more friable B horizon than those soils.

273B—Olmitz loam, 2 to 5 percent slopes. This soil is on smooth or concave foot slopes and on alluvial fans. Areas are narrow and irregular in shape and 5 to 20 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are some areas that have recent overwash of loam, clay loam, silt loam, or silty clay loam.

This soil is mainly used for cultivated crops. It is well suited to row crops. This soil is susceptible to erosion, but sediments from steep adjacent uplands have been deposited in many places. Rills and gullies dissect some of the areas, making farming difficult. Organic matter content is high. Capability unit IIe–3; environmental planting group 1.

273C—Olmitz loam, 5 to 9 percent slopes. This soil is on smooth or concave foot slopes at the base of steep glacial till uplands. Areas are narrow and irregular in shape and 5 to 15 acres in size.

This soil has a profile similar to the one described as representative of the series, but recent overwash has been deposited in some areas. The overwash is very dark grayish brown loam, clay loam, or silt loam that has a high sand content. It is 6 to 12 inches thick.

Included with this soil in mapping in some places adjacent to Shelby or Gara soils are soils that have firm glacial till at a depth of less than 40 inches.

This soil is mainly in crops, but some is in pasture or hay. This soil is managed along with adjacent soils. This soil is moderately well suited to row crops. It is susceptible to erosion. Sediments from steep adjacent uplands have been deposited in a few places. Gullies dissect some areas, making farming difficult. Organic matter content is high. Capability unit IIIe–2; environmental planting group 1.

Otley series

The Otley series consists of moderately well drained soils on uplands. These soils formed in loess under tall prairie grasses. Slopes are 2 to 14 percent.

In a representative profile the surface layer is black and very dark grayish brown silty clay loam about 18 inches thick. The subsoil is brown and yellowish brown, friable silty clay loam in the upper part and grayish brown, friable silty clay loam in the lower part; it extends to a depth of 50 inches. The substratum is mottled grayish brown silty clay loam.

Permeability is moderately slow, and available water capacity is high. Available phosphorus in the subsoil is low, and available potassium is very low.

Otley soils are mainly used for cultivated crops. Erosion is the major hazard.

Representative profile of Otley silty clay loam, 2 to 5 percent slopes, in a pasture, 292 feet south and 194 feet west of the northeast corner of SE¼SE¼ sec. 32, T. 78 N., R. 19 W.:

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam; moderate fine and very fine granular structure; friable; slightly acid; clear smooth boundary.

A12—6 to 12 inches; black (10YR 2/1) silty clay loam; moderate fine granular structure; friable; slightly acid; gradual smooth boundary.

A3—12 to 18 inches; very dark grayish brown (10YR 3/2) silty clay loam, with mixing of very dark gray (10YR 3/1), very dark grayish brown (10YR 3/2) kneaded; moderate fine granular structure; friable; thin patchy discontinuous clay films; medium acid; clear smooth boundary.

B21t—18 to 25 inches; brown (10YR 4/3) silty clay loam, with some mixing of very dark grayish brown (10YR 3/2) and yellowish brown (10YR 5/4); moderate medium and fine subangular blocky structure; friable; thin discontinuous

clay films; medium acid; gradual smooth boundary.

B22t—25 to 32 inches; yellowish brown (10YR 5/4) silty clay loam; few fine distinct yellowish red (5YR 4/8) and grayish brown (2.5Y 5/2) mottles; weak and moderate medium and fine subangular blocky structure; friable; thin discontinuous clay films; medium acid; gradual smooth boundary.

B23t—32 to 39 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine faint brown (10YR 5/3) and yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B3t—39 to 50 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine faint brown (10YR 5/3) and moderate fine distinct yellowish brown (10YR 5/8) mottles; weak coarse prismatic structure parting to medium and fine angular blocky and subangular blocky; friable; thin discontinuous clay films; slightly acid; gradual smooth boundary.

C—50 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine distinct strong brown (7.5YR 5/6) and many fine and medium distinct yellowish brown (10YR 5/8) mottles; massive; friable; few distinct black oxides; medium acid.

The solum ranges from 48 to 60 inches in thickness. The A horizon is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). It is 10 to 20 inches thick unless eroded. It is slightly acid to strongly acid. The B2 horizon is dark brown (10YR 3/3), brown (10YR 4/3 or 5/3), or yellowish brown (10YR 5/4) in the upper part.

Otley soils are near Ladoga and Clinton soils and formed in the same kind of parent material. Otley soils have a thicker dark-colored surface layer and lack the A2 horizon that Clinton and Ladoga soils have in unplowed areas.

281B—Otley silty clay loam, 2 to 5 percent slopes. This soil is on gently sloping, narrow, convex ridgetops. Areas are long and narrow and 10 to 30 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are soils in narrow drainageways that are wetter than this Otley soil. Also included at the heads of drainageways are small areas of wet and seepy soils and soils that have a thicker dark-colored surface layer. These areas are indicated by a special symbol on the soil map.

This soil is mainly used for cultivated crops. It is well suited to row crops. It is susceptible to erosion. Organic matter content is moderate. Capability unit IIe–2; environmental planting group 1.

281C2—Otley silty clay loam, 5 to 9 percent slopes, moderately eroded. This soil is on narrow ridgetops and convex side slopes. Areas are long and narrow and 10 to 30 acres in size.

This soil has a profile similar to the one described as representative of the series, but erosion has removed part of the surface layer. The very dark grayish brown and brown colors in the profile are mixed in the surface layer.

Included with this soil in mapping are small areas of severely eroded soils, areas of red clay, a few spots of sandy soils, and glacial till outcrops. These areas are indicated by special symbols on the soil maps.

This soil is used mainly for cultivated crops. It is moderately well suited to row crops. It is susceptible to erosion. Organic matter content is moderate. Capability unit IIIe–1; environmental planting group 1.

281D2—Otley silty clay loam, 9 to 14 percent slopes, moderately eroded. This soil is on convex side slopes. Areas are long and narrow and 10 to 40 acres in size.

This soil has a profile similar to the one described as representative of the series, but erosion has removed a portion of the surface layer and very dark grayish brown and brown material has been mixed into the plow layer.

Included with this soil in mapping are small areas of shale, till, a red and gray paleosol, and severely eroded soils. These areas are indicated with special symbols on the soil map.

This soil is used for cultivated crops, hay, and pasture. It is moderately well suited to row crops. It is very susceptible to erosion. Organic matter content is moderate. Capability unit IIIe–3; environmental planting group 1.

Port Byron series

The Port Byron series consists of well drained soils on uplands. These soils formed in loess under prairie grass. Slopes are 5 to 25 percent.

In a representative profile the surface layer is very dark grayish brown silt loam 7 inches thick. The upper 5 inches of the subsoil is dark brown, very friable silt loam; and the lower 23 inches is brown and dark yellowish brown, very friable silt loam. The substratum is yellowish brown silt loam.

Permeability is moderate, and available water capacity is high. Available phosphorus in the subsoil is medium, and available potassium is very low.

Port Byron soils are used for cultivated crops, hay, and pasture. Erosion is the major hazard.

Representative profile of Port Byron silt loam, 5 to 9 percent slopes, moderately eroded, in a pasture, 2,310 feet north and 800 feet east of the southwest corner of sec. 2, T. 78 N., R. 19 W.:

A1—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam; weak very fine granular structure; very friable; neutral; gradual smooth boundary.

B1—7 to 12 inches; dark brown (10YR 3/3) silt loam; weak fine subangular blocky structure parting to weak fine granular; very friable; slightly acid; clear smooth boundary.

B2—12 to 20 inches; brown (10YR 4/3) silt loam; dark brown (10YR 3/3) coats; weak coarse prismatic structure parting to weak medium subangular blocky; very

friable; slightly acid; gradual smooth boundary.

B3—20 to 35 inches; dark yellowish brown (10YR 4/4) silt loam, yellowish brown (10YR 5/4) kneaded; brown (10YR 4/3) coats on faces of peds in upper part; weak, coarse prismatic structure; very friable; slightly acid; gradual smooth boundary.

C—35 to 60 inches; yellowish brown (10YR 5/4) silt loam; few fine faint light yellowish brown (10YR 6/4) and light gray (10YR 7/2) mottles; massive; very friable; slightly acid.

The A horizon is slightly acid or neutral. The Ap and A1 horizons are black (10YR 2/1), very dark brown (10YR 2/2), or very dark grayish brown (10YR 3/2). The B2 horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/4). The clay content of the B2 horizon ranges from 18 to 27 percent. Strength of structure is moderate in some pedons.

Port Byron silt loam, 14 to 18 percent slopes, moderately eroded, (620E2) and Port Byron silt loam, 18 to 25 percent slopes, moderately eroded, (620F2) are outside the range defined for the series because slopes are too great, they lack a mollic epipedon and the solum is too thin. Port Byron silt loam, 5 to 9 percent slopes, moderately eroded, (620C2) and Port Byron silt loam, 9 to 14 percent slopes, moderately eroded, (620D2) are within the defined range of the series but are marginal in these properties. These differences do not significantly affect the use and behavior of these soils.

Port Byron soils are near Tama soils, which also formed in loess. Port Byron soils have less clay and weaker structure in the B horizon than Tama soils.

620C2—Port Byron silt loam, 5 to 9 percent slopes, moderately eroded. This soil is on convex ridgetops and side slopes. Areas are irregular in shape and 5 to 15 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Tama soils that have smoother slopes. Also included are some soils in which the subsoil has a high content of coarse silt or very fine sand. The surface layer and the upper part of the subsoil are mixed in plowed areas.

Most areas are cultivated. This soil is moderately well suited to row crops. Erosion is the main hazard. Organic matter content is moderate. Capability unit IIIe–1; environmental planting group 1.

620D2—Port Byron silt loam, 9 to 14 percent slopes, moderately eroded. This soil is on convex side slopes. Areas are irregular in shape and 10 to 30 acres in size.

This soil has a profile similar to the one described as representative of the series, but some of the dark brown subsoil has been mixed into the plow layer in cultivated areas.

Included with this soil in mapping are narrow areas of soils in drainageways. Also included are sandy knolls, severely eroded soils, and calcareous soils. These areas are indicated by special symbols on the soil map.

This soil is used for cultivated crops, hay, and pasture. It is moderately well suited to row crops, but is very susceptible to erosion. Organic matter content is moderate. Capability unit IIIe–3; environmental planting group 1.

620E2—Port Byron silt loam, 14 to 18 percent slopes, moderately eroded. This soil is on convex side slopes adjacent to major streams. Areas are irregular in shape and 10 to 30 acres in size.

The surface layer is very dark grayish brown or dark brown and is about 7 inches thick. It is underlain by a brown subsoil. In cultivated areas some of the brown subsoil commonly is mixed into the plow layer.

Included with this soil in mapping are small areas of severely eroded Port Byron soils, sandy soils, calcareous soils, and soils that formed in glacial till. These areas are indicated by special symbols on the soil map. Narrow areas of wetter soils in drainageways are also included.

This soil is mainly used for hay and pasture, but it is also planted to cultivated crops. It is well suited to small grain, pasture, or hay. Row crops can be grown occasionally if erosion is controlled. Erosion is the main hazard. Because of rapid runoff, droughtiness is a problem during prolonged dry periods. Capability unit IVe–1; environmental planting group 1.

620F2—Port Byron silt loam, 18 to 25 percent slopes, moderately eroded. This soil is on convex side slopes adjacent to major streams. Areas are irregular in shape and 15 to 35 acres in size.

The surface layer is very dark grayish brown or dark brown and is about 7 inches thick. It is underlain by a brown subsoil. In cultivated areas some of the brown subsoil is mixed into the plow layer.

Included with this soil in mapping are small areas of severely eroded Port Byron soils, sandy soils, calcareous soils, and soils that formed in glacial till. These areas are indicated by special symbols on the soil map. Narrow areas of wetter soils in drainageways are also included.

This soil is well suited to pasture, and this is the main use. Corn can be planted occasionally as a first step in renovating pasture, except in areas that are too steep for use of farm machinery. The main hazards are sheet and gully erosion. Because of the rapid runoff, droughtiness is also a problem during long dry periods. Organic matter content is moderate. Capability unit VIe–1; environmental planting group 1.

Shelby series

The Shelby series consists of moderately well drained soils on uplands. These soils formed in glacial till under prairie grasses. Slopes are 9 to 25 percent.

In a representative profile the surface layer is black loam about 6 inches thick. The upper 6 inches of the subsoil is dark brown, friable clay loam, and the lower 36 inches is brown and yellowish brown, firm clay loam. The substratum is grayish brown clay loam. Pebbles and stones are throughout the profile.

Permeability is moderately slow, and available water capacity is high. Available phosphorus is low, and available potassium is high in the subsoil.

Shelby soils are mainly used for hay and pasture. Erosion is the major hazard.

Representative profile of Shelby loam, 18 to 25 percent slopes, moderately eroded, in bluegrass pasture, 200 feet south and 400 feet east of the northwest corner of SW¼SW¼ sec. 3, T. 81 N., R. 19 W.:

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) crushed; weak fine granular structure; friable; neutral; clear smooth boundary.

B1—6 to 12 inches; dark brown (10YR 3/3) clay loam, dark brown (10YR 3/3) kneaded; very dark grayish brown (10YR 3/2) coats on faces of peds; weak fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.

B21t—12 to 19 inches; brown (10YR 4/3) clay loam; dark brown (10YR 3/3) coats on faces of peds; weak and moderate fine and medium subangular blocky structure; firm; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B22t—19 to 26 inches; yellowish brown (10YR 5/4) clay loam; brown (10YR 4/3) coats on faces of peds; few fine faint yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; firm; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B23t—27 to 36 inches; yellowish brown (10YR 5/4) clay loam; few fine faint grayish brown (10YR 5/2) and brown (10YR 5/3) mottles; moderate fine and medium subangular blocky structure; firm; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B3t—36 to 48 inches; brown (10YR 5/3) and yellowish brown (10YR 5/4) clay loam; common medium faint yellowish brown (10YR 5/6 and 5/8) mottles; weak medium prismatic structure parting to weak fine and medium angular and subangular blocky; firm; thin discontinuous clay films on faces of peds; slightly acid; clear smooth boundary.

C—48 to 60 inches; grayish brown (2.5Y 5/2) clay loam; many medium distinct yellowish brown (10YR 5/6 and 5/8) mottles; massive; firm; common soft carbonate nodules; neutral.

The thickness of the solum is generally 40 to 60 inches but ranges from 36 to 72 inches. The A horizon is black (10YR 2/1) to very dark grayish brown (10YR 3/2) loam or light clay loam. In uneroded areas it is 10 to 18 inches thick. The B2 horizon is dark brown (10YR 3/3) to yellowish brown (10YR 5/4 and 5/6 or 5/8) clay loam. The B2 horizon is 12 to 36 inches thick and is slightly acid or neutral. The B3 horizon is medium to light clay loam. The C horizon is light brownish gray (10YR 6/2) or grayish brown (2.5Y 5/2) and is neutral to moderately alkaline.

Shelby soils formed in the same kind of parent material as Gara and Lindley soils. They typically have a thicker dark-colored surface layer than those soils, and they lack an A2 horizon, which is present in Gara and Lindley soils that have not been plowed or eroded.

24D2—Shelby loam, 9 to 14 percent slopes, moderately eroded. This soil occurs as long, irregular bands on the lower part of convex side slopes. Areas are 5 to 30 acres in size.

This soil has a profile similar to the one described as representative of the series, but dark brown subsoil material is mixed into the surface layer or exposed at the surface in many places.

Included with this soil in mapping are small areas of severely eroded soils and sandy soils, which are indicated by special symbols on the soil map. Also included is a slightly eroded Shelby soil near the base of slopes. This soil receives runoff and sediment from upslope, and it has an unusually thick dark colored surface layer in places. Small areas of Adair and Lamoni soils are included and are indicated by special symbols on the soil map. In places the subsoil has more sand than is typical of Shelby loam.

This soil is used for cultivated crops, hay, and pasture. It is moderately well suited to row crops. Erosion is the main hazard. Maintaining good tilth is a problem where considerable amounts of subsoil material have been mixed into the plow layer. Organic matter content is moderate. Capability unit IIIe–3; environmental planting group 1.

24E2—Shelby loam, 14 to 18 percent slopes, moderately eroded. This soil occurs as bands on lower side slopes. Areas are typically 10 to 30 acres in size.

This soil has a profile similar to the one described as representative of the series, but in cultivated areas the plow layer is a black, dark brown, and brown mixture of surface layer and subsoil material.

Included with this soil in mapping are areas of severely eroded soils and spots of red and gray clay, which are indicated by special symbols on the soil map.

Most areas are in hay or pasture, but some areas are cultivated. This soil is better suited to hay and pasture than to row crops. Corn and soybeans can be grown occasionally if erosion is controlled. Maintaining good tilth is a problem where considerable amounts of subsoil material have been mixed into the plow layer. Organic matter content is moderate. Capability unit IVe–1; environmental planting group 1.

24F2—Shelby loam, 18 to 25 percent slopes, moderately eroded. This soil is on side slopes. Areas are typically irregular in shape and 10 to 25 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Adair and Lamoni soils. These soils have a clay loam surface layer. They are indicated by a special symbol on the soil map as a red clay or gray clay spot. Spots of severely eroded soils are also indicated by a special symbol on the soil map. Some areas of Shelby soils that are less eroded than this soil are also included.

This soil is mainly in pasture. Most of the areas, however, were formerly cultivated. This soil is well suited to hay or pasture. Erosion is the main hazard. Organic matter content is moderate. Capability unit VIe–1; environmental planting group 1.

93D2—Shelby-Adair complex, 9 to 14 percent slopes, moderately eroded. The soils of this complex are on convex side slopes in the upper reaches of drainage systems. Areas are usually narrow, ribbonlike bands that follow the contour of the side slope. The Adair

soils are on convex knobs and shoulders on the upper part of the slope, and the Shelby soils are on convex smooth side slopes below the Adair soils. Shelby soils generally occupy about 60 percent of the area and Adair 40 percent.

Included with this complex in mapping are small areas of Lamoni and Clarinda soils. Seep areas are common in these soils. Areas of wet soils and spots of severely eroded soils are indicated by special symbols on the soil map.

This complex is well suited to hay or pasture. Row crops can be grown occasionally if erosion is controlled. Maintaining good tilth is a problem where considerable amounts of subsoil material have been mixed into the plow layer. The wetness caused by seeps in the Adair soils makes timely field operations important. Organic matter content is generally low. Capability unit IVe–2; environmental planting group 1.

93E2—Shelby-Adair complex, 14 to 18 percent slopes, moderately eroded. This complex is on convex side slopes in upper reaches of drainage systems. Areas are commonly narrow, ribbonlike bands that follow the contour of the side slope. The Adair soils are on convex knobs and shoulders on the upper part of the slope and make up about 30 percent of the unit. The Shelby soils are on convex slopes below the Adair soils and make up about 70 percent of the unit.

Included with this soil in mapping are small areas of Lamoni and Clarinda soils. Seeps are common in those soils. Areas of wet soils and spots of severely eroded soils are indicated by special symbols on the soil map.

This complex is well suited to hay and pasture, and it is mainly used for those purposes. An occasional year of corn can be grown as the first step in reseeding or renovating pasture. These soils are very susceptible to sheet and gully erosion. Organic matter content is generally low. Capability unit VIe–2; environmental planting group 1.

Sparta series

The Sparta series consists of excessively drained soils on uplands and stream benches. These soils formed in eolian sand, wind-reworked alluvium, and outwash sand under mixed prairie grasses and widely spaced oak and hickory trees. Slopes are 1 to 18 percent.

In a representative profile the surface layer is very dark brown loamy fine sand and very dark grayish brown loamy sand about 16 inches thick. The subsoil extends to a depth of 38 inches. It is brown, dark grayish brown, and yellowish brown, loose loamy sand. The substratum is yellowish brown loamy sand.

Permeability is very rapid, and available water capacity is low. Available phosphorus and potassium are very low in the subsoil.

Sparta soils are used for cultivated crops, hay, and pasture. Erosion, soil blowing, and droughtiness are the major hazards.

Representative profile of Sparta loamy fine sand, 1 to 5 percent slopes, in pasture, 800 feet east and 40 feet south of the northwest corner of the SW¼SW¼ of sec. 35, T. 80 N., R. 20 W.:

A1—0 to 10 inches; very dark brown (10YR 2/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; very weak medium and fine subangular blocky structure parting to weak fine granular; very friable; slightly acid; clear smooth boundary.

A12—10 to 16 inches; very dark grayish brown (10YR 3/2) loamy sand, dark grayish brown (10YR 4/2) and brown (10YR 5/3) dry; very weak medium and fine subangular blocky structure parting to fine granular and single grained; very friable; slightly acid; clear wavy boundary.

B21—16 to 30 inches; brown (10YR 4/3) and dark grayish brown (10YR 4/2) loamy sand, brown (10YR 5/3) dry; ½-inch-thick band of dark brown (7.5Y 3/2) material at depth of 30 inches; single grained; loose; slightly acid; gradual wavy boundary.

B22—30 to 38 inches; yellowish brown (10YR 5/4) loamy sand, pale brown (10YR 6/3) dry; 1-inch-thick band at depth of 33 inches and 2-inch-thick band at depth of 38 inches of brown (7.5YR 4/4) material; single grained; loose; slightly acid; gradual smooth boundary.

C—38 to 69 inches; yellowish brown (10YR 5/4) loamy sand, pale brown (10YR 6/3) dry; 2-inch-thick band at depth of 52 inches and 1-inch-thick band at depth of 62 inches of brown (7.5YR 4/4) material; single grained; loose; slightly acid.

The solum ranges from 24 inches to about 40 inches in thickness. The A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). An A3 horizon is present in places. The A horizon is loamy sand or loamy fine sand. It is 10 to 24 inches thick and is neutral or slightly acid. The B2 horizon ranges from dark yellowish brown (10YR 4/4) to brownish yellow (10YR 6/6) and includes bands of dark brown (7.5YR 3/2) or brown (7.5YR 4/4). The B2 horizon is loamy sand or loamy fine sand. It is slightly acid or medium acid. The C horizon ranges from dark yellowish brown (10YR 4/4) to brownish yellow (10YR 6/6) and pale brown (7.5YR 6/3). It includes narrow bands of dark brown (7.5YR 4/4) and strong brown (7.5YR 5/6). The C horizon ranges from loamy sand to fine sand. It is slightly acid or medium acid.

Sparta soils are near Chelsea and Dickinson soils and formed in the same kind of parent material. Sparta soils have a thicker, darker colored surface layer than Chelsea soils. They contain more sand in the subsoil than Dickinson soils.

41B—Sparta loamy fine sand, 1 to 5 percent slopes. This soil is on convex uplands adjacent to major drainageways and in hummocky areas on stream benches. Areas are irregular in shape and 5 to 20 acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of soils eroded by wind. These areas are indicated by

a special symbol on the soil maps. Also included are some areas of soils that are less sandy than Sparta soils.

This soil is mainly used for hay and pasture, but many of the smaller areas are managed with adjoining soils and are planted to row crops. This soil is better suited to hay and pasture. It is very droughty. It is susceptible to soil blowing, and sloping areas are subject to erosion. Organic matter content is low. Capability unit IVs–1; environmental planting group 3.

41C2—Sparta loamy fine sand, 5 to 9 percent slopes, moderately eroded. This soil is on convex side slopes on uplands and in northwest-southeast oriented hummocky areas on benches along the major streams. Areas are irregular in shape and 5 to 30 acres in size.

This soil has a profile similar to the one described as representative of the series, but erosion has removed part of the surface layer. Cultivated areas have a very dark grayish brown plow layer that is mixed with the brown subsoil material in many places.

Included with this soil in mapping are a few areas of soils that have been severely eroded. These areas are indicated by a special symbol on the soil map. Also included are some soils that are less sandy than Sparta soils.

Most areas are used for hay and pasture, but some are managed with adjoining soils and planted mainly to cultivated crops. This soil is better suited to hay and pasture, but it can be used for row crops occasionally. This soil is droughty and is susceptible to erosion and soil blowing. Organic matter content is low. Capability unit IVs–1; environmental planting group 3.

41D2—Sparta loamy fine sand, 9 to 18 percent slopes, moderately eroded. This soil is on convex side slopes on uplands adjacent to major streams. Areas are irregular in shape and 5 to 15 acres in size.

This soil has a profile similar to the one described as representative of the series, but some of the surface layer has been removed by erosion. The surface layer is very dark grayish brown and is about 10 inches thick. In cultivated areas, some of the brown subsoil has generally been mixed into the surface layer.

Included with this soil in mapping are spots of severely eroded soils and a few areas of exposed glacial till. These areas are indicated by special symbols on the soil maps. Also included are some soils that are less sandy than Sparta soils.

This soil is well suited to pasture and is mainly used for that purpose. It can also be used for hay. It is very droughty and is subject to soil blowing and water erosion. Organic matter content is low. Capability unit VIs–1; environmental planting group 3.

Sperry series

The Sperry series consists of very poorly drained to poorly drained soils on uplands. These soils formed in local alluvium and in the underlying loess. Native vegetation is tall prairie grasses that are tolerant to wetness. Slopes are 0 to 1 percent.

In a representative profile the surface layer is black silt loam about 10 inches thick. The subsurface layer is dark gray and grayish brown silt loam about 7 inches thick. The subsoil extends to a depth of 48 inches; it is dark gray, firm silty clay in the upper part and gray, firm silty clay loam in the lower part. The substratum is gray silty clay loam to a depth of 60 inches.

Permeability is slow to very slow, and available water capacity is high. Available phosphorus and potassium are very low in the subsoil.

Sperry soils are mainly used for cultivated crops. Wetness is the main limitation.

Representative profile of Sperry silt loam, 0 to 1 percent slopes, in a cultivated field, 500 feet west and 400 feet north of the southeast corner of NE¼SE¼ sec. 33, T. 80 N., R. 18 W.:

Ap—0 to 10 inches; black (10YR 2/1) silt loam, some mixing of very dark gray (10YR 3/1); weak fine granular structure; friable; neutral; clear smooth boundary.

A2—10 to 17 inches; dark gray (10YR 4/1) and grayish brown (10YR 5/2) silt loam; black (10YR 2/1) worm casts; few fine faint brown (10YR 4/3) mottles; weak thin platy structure parting to weak fine granular; friable; few fine dark-colored accumulations of manganese oxides; neutral; abrupt smooth boundary.

B21tg—17 to 32 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) kneaded; very dark gray (10YR 3/1) faces of peds; few fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; strong fine and medium subangular blocky structure; firm; thick continuous clay films; neutral; gradual smooth boundary.

B22tg—32 to 36 inches; gray (10YR 5/1) heavy silty clay loam; few fine distinct yellowish brown (10YR 5/4 and 5/6) mottles; moderate medium and weak coarse prismatic structure parting to moderate fine and medium blocky; firm; thick continuous clay films; slightly acid; gradual smooth boundary.

B3tg—36 to 48 inches; gray (5Y 5/1) silty clay loam; few fine distinct yellowish brown (10YR 5/4 and 5/6) and few fine prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; firm; few fine dark-colored accumulations of manganese oxides; thin discontinuous clay films; neutral; gradual smooth boundary.

C1—48 to 54 inches; gray (5Y 5/1) silty clay loam; few fine prominent strong brown (7.5YR 5/6 and 5/8) mottles; massive; firm; few fine dark accumulations of manganese oxides; neutral; gradual smooth boundary.

C2—54 to 60 inches; gray (5Y 5/1) silty clay loam; few fine prominent yellowish red (5YR 4/8) mottles; massive; firm; few fine dark-colored accumulations of manganese oxides; neutral.

The solum ranges from 40 to 68 inches in thickness. The A1 horizon is black (10YR 2/1) or very dark gray (10YR 3/1). It is 10 to 12 inches thick and is neutral to medium acid. The A2 horizon is 6 to 8 inches thick and ranges from strongly acid to neutral. The

B2 horizon is dark gray (10YR 4/1 or 5Y 4/1), gray (10YR 5/1 or 5Y 5/1), light olive gray (5Y 6/2), grayish brown (2.5Y 5/2), or light brownish gray (2.5Y 6/2). The C horizon is slightly acid or neutral.

Sperry soils are in depressions within larger areas of Garwin and Taintor soils and formed in similar parent material. They have a thinner A1 horizon than the Garwin and Taintor soils, and they have an A2 horizon, which those soils lack.

122—Sperry silt loam, 0 to 1 percent slopes. This soil is in slight depressions on broad divides. Areas are typically almost circular but are elongated in places. They are about 2 to 8 acres in size. Many areas are too small to delineate on the soil map and are indicated by a wet spot symbol in areas of surrounding soils.

Some small depressional areas of the Sperry soil are joined by including the thin band of Taintor or Garwin soil that lies between the depressions.

This soil is managed with the surrounding soils. If drainage is adequate, it is used intensively for row crops. Areas without artificial drainage tend to pond water. Those areas are often left idle. Crops are subject to drowning.

This soil is moderately well suited to row crops if drainage is adequate. During wet periods a perched water table develops over the slowly to very slowly permeable subsoil. Organic matter content is moderate to high. Capability unit IIIw–2; environmental planting group 2.

Storden series

The Storden series consists of somewhat excessively drained soils on uplands. These soils formed in glacial till under prairie grasses. Slopes are 5 to 25 percent.

In a representative profile the surface layer is dark grayish brown loam about 8 inches thick. The substratum is dark yellowish brown, friable loam to a depth of 18 inches. Below this it is light olive brown, friable loam.

Permeability is moderate, and available water capacity is high. Available phosphorus and potassium are very low beneath the surface layer.

Less sloping Storden soils are used for cultivated crops, hay, and pasture. Steeper Storden soils are mainly used for pasture. Erosion is the main hazard.

Representative profile of Storden loam, 5 to 14 percent slopes, in a cultivated field, 200 feet north and 306 feet west of southeast corner of NE¼NE¼ sec. 18, T. 80 N., R. 21 W.:

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loam, same color kneaded; weak fine granular structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

C1—8 to 18 inches; dark yellowish brown (10YR 4/4) loam; massive; friable; strong effervescence; mildly alkaline; diffuse boundary.

C2—18 to 60 inches; light olive brown (2.5Y 5/6) loam; few fine distinct yellowish red (5YR 5/6) mottles; massive; friable; few fine prominent black accumulations of oxides; strong effervescence; moderately alkaline.

The thickness of the solum is commonly the same as the thickness of the A horizon. The Ap horizon is dark grayish brown (10YR 4/2), grayish brown (10YR 5/2), or brown (10YR 4/3) loam or light clay loam. The C horizon ranges from dark yellowish brown (10YR 4/4) or yellowish brown (10YR 5/4) to light olive brown (2.5Y 5/6). The depth to calcareous material is 6 to 12 inches in many places, but in other places these soils are calcareous at the surface. Some Storden soils have weak structure in the upper part of the C horizon.

Storden soils formed in glacial till materials similar to those of Clarion soils. Storden soils lack the B horizon typical of Clarion soils and are not so deep to lime as those soils.

62D—Storden loam, 5 to 14 percent slopes. These soils are mainly on convex ridgetops and side slopes. In most places areas are irregular in shape and 5 to 30 acres in size.

This soil has the profile described as representative of the series. Included with this soil in mapping are small areas of Clarion soils. Small areas of severely eroded soils and sandy knolls are also included and are indicated by special symbols on the soil map.

Most areas are used for cultivated crops or hay. This soil is moderately well suited to row crops. It is susceptible to erosion. Because runoff is rapid, this soil is droughty. Organic matter content is low. Capability unit IIIe–3; environmental planting group 1.

62E—Storden loam, 14 to 18 percent slopes. This soil is on convex side slopes. Areas are irregular in shape and 10 to 60 acres in size.

This soil has a profile similar to the one described as representative of the series, but in most places the dark grayish brown surface layer is mixed with dark yellowish brown and yellowish brown material from beneath.

Included with this soil in mapping are areas of severely eroded soils and sandy knolls and ridges too small to show separately on the soil map.

Some areas of this soil are cultivated, but the soil is better suited to meadow or pasture. Row crops can be grown occasionally if erosion is controlled. This soil is very susceptible to erosion. Because of the rapid runoff, this soil tends to be droughty. Organic matter content is low. Capability unit IVe–1; environmental planting group 1.

62F—Storden loam, 18 to 25 percent slopes. These soils are on convex side slopes. Areas are irregular in shape and 10 to 25 acres in size.

This soil has a profile similar to the one described as representative of the series, but much of the dark grayish brown surface layer has been removed by erosion and the surface layer is just a few inches thick. In cultivated areas the plow layer is made up mostly of dark yellowish brown material mixed with the original surface layer.

Included with this soil in mapping are some very steep Storden soils. In some places this unit includes some steep Clarion soils. Small areas of severely eroded soils and a few sandy knolls and ridges are included in mapping. These areas are indicated by special symbols on the soil map.

This Storden soil is well suited to pasture, and is mainly used for that purpose. It is very susceptible to erosion and is droughty. Runoff is excessive. Organic matter content is low. Capability unit VIe–1; environmental planting group 1.

Taintor series

The Taintor series consists of poorly drained soils on uplands. These soils formed in loess under tall prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black silty clay loam about 19 inches thick. The subsoil is firm silty clay loam and extends to a depth of 60 inches; it is very dark gray, dark grayish brown, and dark gray in the upper part and mottled olive gray, yellowish brown, and strong brown in the lower part.

Permeability is slow to moderately slow, and available water capacity is high. Available phosphorus and potassium are very low in the subsoil.

Taintor soils are used for cultivated crops. Wetness is a limitation.

Representative profile of Taintor silty clay loam, 0 to 2 percent slopes, in a cultivated field, 400 feet west and 300 feet north of southeast corner of NW¼ SE¼ sec. 13, T. 78 N., R. 21 W.:

Ap—0 to 7 inches; black (N 2/0) light silty clay loam, black (10YR 2/1) kneaded; weak fine granular structure; friable; medium acid; gradual smooth boundary.

A12—7 to 14 inches; black (N 2/0) silty clay loam, black (10YR 2/1) kneaded; weak fine granular structure; friable; medium acid; gradual smooth boundary.

A3—14 to 19 inches; black (10YR 2/1) silty clay loam; weak fine and very fine subangular blocky and granular structure; friable; medium acid; gradual smooth boundary.

B1tg—19 to 24 inches; very dark gray (10YR 3/1) silty clay loam; weak fine subangular blocky structure; firm; thin discontinuous clay films on faces of peds; strongly acid; clear smooth boundary.

B21tg—24 to 30 inches; dark grayish brown (2.5Y 4/2) silty clay loam; very dark grayish brown (2.5Y 3/2) coats on faces of peds; few fine faint yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to moderate and strong fine and medium subangular blocky; firm; common thin discontinuous clay films on faces of peds; light brownish gray (10YR 6/2) silt coats; few black (5Y 2/1) organic coats; strongly acid; gradual smooth boundary.

B22tg—30 to 36 inches; dark gray (10YR 4/1) silty clay loam, gray (5Y 5/1) kneaded; few fine faint yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure parting to moderate and strong fine and medium subangular blocky; firm; common thin discontinuous clay films on faces of peds; light brownish gray (10YR 6/2) silt coats; very dark brown (10YR 2/2) organic coats; strongly acid; gradual smooth boundary.

B23tg—36 to 44 inches; mottled olive gray (5Y 4/2), yellowish brown (10YR 5/6), and strong brown (7.5YR 5/8) silty clay loam, grayish brown (10YR 5/2) kneaded; weak coarse prismatic structure parting to moderate and strong fine and medium subangular blocky; firm; common thin discontinuous clay films on faces of peds; dark organic coats; medium acid; gradual smooth boundary.

B31g—44 to 52 inches; mottled olive gray (5Y 5/2), yellowish brown (10YR 5/6), and strong brown (7.5YR 5/8) silty clay loam, olive (5Y 5/4) kneaded; weak coarse prismatic structure parting to weak and moderate medium subangular blocky; firm; common thin discontinuous clay films on faces of peds; medium acid; gradual smooth boundary.

B32g—52 to 60 inches; mottled olive gray (5Y 5/2), yellowish brown (10YR 5/6), and strong brown (7.5YR 5/8) silty clay loam, olive brown (2.5Y 4/4) kneaded; weak coarse prismatic structure; firm; some dark minerals; thin discontinuous clay films on faces of peds; medium acid.

The solum ranges from 42 to 72 inches in thickness. The A horizon is 16 to 21 inches thick. The texture ranges from light silty clay loam to heavy silty clay loam. The B2t horizon averages 36 to 42 percent clay.

Taintor soils are near Otley soils and formed in the same kind of parent material. Taintor soils have a grayer subsoil than Mahaska soils. They have a thicker dark colored surface layer than Otley soils.

279—Taintor silty clay loam, 0 to 2 percent slopes. This soil is in smooth or slightly depressional areas on upland divides. Areas are irregular in shape and 10 to 80 acres in size.

Included with this soil in mapping are Sperry soils in small swales or depressional areas and small areas of the better drained Mahaska soils in slightly convex areas.

Corn and soybeans are the major crops. This soil is well suited to row crops. Wetness is a limitation. Open surface drainage or tile, or both, are needed for optimum crop growth. Organic matter content is high. Capability unit IIw–3; environmental planting group 2.

Tama series

The Tama series consists of well drained soils on uplands and stream benches. These soils formed in loess under grass. Slopes are 0 to 14 percent.

In a representative profile (fig. 12) the surface layer is very dark brown and very dark gray silty clay loam 15 inches thick. The subsoil extends to a depth of 42 inches and is friable silty clay loam; it is very dark grayish brown in the upper 4 inches and brown in the lower 23 inches. It is underlain by yellowish brown silty clay loam.

Permeability is moderate, and available water ca-

Figure 12.—**Profile of a Tama silty clay loam. Arrow indicates the thickness of the dark-colored surface layer.**

pacity is high. Available phosphorus in the subsoil is medium, and available potassium is very low.

Tama soils are mainly used for cultivated crops. Erosion is a hazard on all sloping Tama soils.

Representative profile of Tama silty clay loam, 2 to 5 percent slopes, in a cultivated field, 920 feet west and 1,360 feet north of the southeast corner of the SW¼ sec. 13, T. 81 N., R. 17 W.:

Ap—0 to 5 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) crushed; weak fine granular structure; friable; neutral; clear smooth boundary.

A12—5 to 10 inches; very dark brown (10YR 2/2) silty clay loam; very dark grayish brown (10YR 3/2) crushed; moderate fine subangular blocky structure parting to moderate fine granular; friable; slightly acid; gradual smooth boundary.

A13—10 to 15 inches; very dark gray (10YR 3/1) silty clay loam, some mixing of very dark grayish brown (10YR 3/2); weak fine subangular blocky structure parting to moderate medium granular; friable; slightly acid; gradual smooth boundary.

B1t—15 to 19 inches; very dark grayish brown (10YR 3/2) silty clay loam; weak fine subangular blocky structure parting to moderate medium granular; friable; slightly acid; gradual smooth boundary.

B2t—19 to 30 inches; brown (10YR 4/3) silty clay loam; few fine distinct yellowish brown (10YR 5/8) mottles in lower part; moderate fine subangular blocky structure; friable; thin patchy discontinuous clay films; slightly acid; gradual smooth boundary.

B3t—30 to 42 inches; brown (10YR 4/3) silty clay loam; common fine distinct yellowish brown (10YR 5/8) and few fine faint light gray (10YR 6/1) mottles; moderate fine subangular blocky structure; friable; thin discontinuous clay films; medium acid; gradual smooth boundary.

C—42 to 60 inches; yellowish brown (10YR 5/4) silty clay loam; many fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; medium acid.

The solum ranges from 42 to 60 inches in thickness. Carbonates are generally absent above a depth of 60 inches. As slope increases, thickness of the A horizon, maximum depth to clay, maximum percent clay, thickness of the B2t horizon, depth to carbonates, and the thickness of the solum commonly decrease. The A horizon ranges from 10 to 18 inches in thickness if not eroded. The A horizon is heavy silt loam or light silty clay loam. It is black (10YR 2/1), very dark gray (10YR 3/1), or very dark brown (10YR 2/2). The B horizon is 22 to 40 inches thick. The upper part of the B horizon in moderately eroded phases is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3). Gray silty coats are evident in places. The weighted clay content of the B horizon does not exceed 35 percent.

Tama soils formed in similar parent material and occupy somewhat similar landscape positions as Otley soils. Tama soils are less mottled and generally have higher chroma and lower clay content in the B horizon than Otley soils.

120—Tama silty clay loam, 0 to 2 percent slopes. This soil is on broad, slightly convex divides. Areas are 10 to 20 acres in size.

Included with this soil in mapping are small areas of somewhat poorly drained Muscatine soils.

This soil is well suited to row crops. Almost all areas except those in farmsteads are used for cultivated crops. There are no serious limitations. Organic matter content is high. Capability unit I–1; environmental planting group 1.

120B—Tama silty clay loam, 2 to 5 percent slopes. This soil is on moderately wide convex ridgetops and side slopes. Areas range from 20 acres to several hundred acres in size.

This soil has the profile described as representative of the series.

Included with this soil in mapping are some gently sloping Tama soils that are moderately eroded.

This soil is used for cultivated crops. It is very fertile and is well suited to row crops. Some individual areas are large enough to be farmed separately. Organic matter content is high. Erosion is a slight hazard. Capability unit IIe–2; environmental planting group 1.

120C2—Tama silty clay loam, 5 to 9 percent slopes, moderately eroded. This soil is on narrow, convex

ridges and side slopes on uplands. Areas generally range from 20 acres to several hundred acres in size.

This soil has a profile similar to the one described as representative of the series, but it has a very dark grayish brown surface layer that is mixed with subsoil material in plowed areas.

Included with this soil in mapping are small areas of Colo and Judson soils in narrow drainageways. Also included are some areas of moderately sloping Tama soils that are uneroded.

Most areas are used for cultivated crops. This soil is moderately well suited to row crops. Erosion is the main hazard. Organic matter content is moderate. Capability unit IIIe–1; environmental planting group 1.

120D2—Tama silty clay loam, 9 to 14 percent slopes, moderately eroded. This soil is mainly on convex side slopes, but a few areas are on narrow, convex ridgetops. Areas range from 10 acres to several hundred acres.

This soil has a profile similar to the one described as representative of the series, but both the surface layer and subsoil are thinner. The surface layer of this soil is very dark grayish brown. In cultivated areas subsoil material is mixed into the plow layer.

Included with this soil in mapping in places are Colo and Judson soils in narrow drainageways. Also included is a soil underlain at a shallow depth by clayey sediment. Severely eroded areas are also included and are indicated by a special symbol on the soil map.

This soil is mainly used for cultivated crops, but a larger proportion is in hay or pasture than is common for Tama soils. This soil is moderately well suited to row crops if erosion is controlled. Organic matter content is moderate. Capability unit IIIe–3; environmental planting group 1.

T120B—Tama silty clay loam, benches, 2 to 5 percent slopes. This soil is on stream benches that are generally about 10 to 20 feet higher than the flood plain. Areas are irregular in shape and 5 to 40 acres in size.

This soil has a profile similar to the one described as representative of the series. This soil, however, is normally underlain by stratified alluvial deposits instead of by glacial till, as is typical in the uplands. This underlying material is as shallow as about 6 feet.

Included with this soil in mapping are areas where the alluvial material is at a depth of 15 feet or more. Also included are some nearly level Tama soils and some moderately sloping Tama and Downs soils.

This soil is well suited to row crops. Corn and soybeans are the major crops. Erosion is a hazard. In places this soil receives runoff from adjoining upland soils. This runoff increases the erosion hazard and causes siltation. The underlying alluvial material commonly is coarse textured and is rapidly permeable. This must be considered when constructing reservoirs and other types of structures. Organic matter content is high. Capability unit IIe–2; environmental planting group 1.

T120C—Tama silty clay loam, benches, 5 to 9 percent slopes. This soil is on high benches that extend out from the base of upland slopes and on convex benches above the flood plains. Areas are 5 to 15 acres in size.

This soil has a profile similar to the one described as representative of the series, but in many areas that have been plowed some very dark grayish brown or brown subsoil material has been mixed into the plow layer. This soil is also typically underlain by stratified alluvial sediments instead of glacial till. The sediments are as shallow as 6 feet.

Included with this soil in mapping are areas where the sediments are 15 feet or more deep. Also included are some strongly sloping Tama soils on short side slopes of benches. On some knolls are small sandy areas that are indicated by a special symbol on the soil map.

This soil is well suited to row crops, and nearly all areas are cultivated. Erosion is a hazard. The hazard is increased in places by runoff from adjoining upland soils. The underlying alluvial material commonly is coarse textured and is rapidly permeable. This must be considered when building reservoirs and other types of structures. Organic matter content is moderate. Capability unit IIIe–1; environmental planting group 1.

Terril series

The Terril series consists of moderately well drained soils on foot slopes and alluvial fans. These soils formed in loamy local alluvium derived from glacial till under tall grasses. Slopes are 2 to 5 percent.

In a representative profile the surface layer is about 30 inches thick. It is black loam to a depth of 25 inches and very dark gray and very dark grayish brown clay loam to a depth of 30 inches. The subsoil is brown, friable clay loam that extends to a depth of 42 inches. The substratum is yellowish brown clay loam and loam to a depth of 60 inches.

Permeability is moderate, and available water capacity is high. Available phosphorus and potassium are very low in the subsoil.

Terril soils are mainly used for cultivated crops. These soils receive runoff from adjacent uplands, which causes rilling or gullying and deposition of sediment.

Representative profile of Terril loam, 2 to 5 percent slopes, in a cultivated field, 93 feet west and 600 feet north of southeast corner NE¼ sec. 30, T. 81 N., R. 21 W.:

Ap—0 to 7 inches; black (10YR 2/1) loam; weak fine granular structure; friable; slightly acid; gradual smooth boundary.

A12—7 to 14 inches; black (10YR 2/1) loam; weak fine and medium subangular blocky structure parting to weak fine granular; friable; slightly acid; gradual smooth boundary.

A13—14 to 25 inches; black (10YR 2/1) heavy loam, very dark grayish brown (10YR 3/2) kneaded; weak fine subangular blocky structure; friable; neutral; clear wavy boundary.

A3—25 to 30 inches; very dark gray (10YR 3/1) very dark grayish brown (10YR 3/2) light clay loam, very dark grayish brown (10YR 3/2) kneaded; weak fine and medium subangular blocky structure; friable; neutral; gradual smooth boundary.

B2—30 to 42 inches; brown (10YR 4/3) light

clay loam; dark brown (10YR 3/3) coats on peds; weak medium subangular blocky structure; friable; neutral; gradual smooth boundary.

C1—42 to 49 inches; yellowish brown (10YR 5/4) light clay loam; few brown (10YR 4/3) coats on peds; few fine faint strong brown (7.5YR 5/6) mottles; weak coarse and medium subangular blocky structure; friable; few dark colored accumulations of oxides; mildly alkaline; gradual smooth boundary.

C2—49 to 60 inches; yellowish brown (10YR 5/4) loam; few fine faint strong brown (7.5YR 5/6) mottles; massive; friable; thin discontinuous dark brown (10YR 4/3) coats on cleavage faces; mildly alkaline.

The solum ranges from 36 to 54 inches in thickness. The A horizon is 24 to 36 inches thick and is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). It is loam or light clay loam and is neutral or slightly acid. A thin B1 horizon of dark grayish brown (10YR 4/2) is present in some places. The B2 horizon is dark brown (10YR 3/3) or brown (10YR 4/3) loam or clay loam. It is slightly acid or neutral. The lower part of the B horizon and the C horizon are calcareous in some profiles. In some profiles the upper boundary of the glacial till is between depths of 40 and 60 inches.

Terril soils lie downslope from Clarion, Lester, and Hayden soils of the uplands. They have a thicker dark colored surface layer than those soils.

27B—Terril loam, 2 to 5 percent slopes. This soil is on slightly concave foot slopes and on convex alluvial fans. Most areas are long, narrow strips that range from 5 acres to more than 50 acres in size.

Included with this soil in mapping are some soils that are not so well drained as this Terril soil. The surface layer is thinner and sandier in some places than is typical for Terril soils.

This soil is used for cultivated crops. A few inaccessable areas are left in pasture. This soil is well suited to row crops. Runoff from adjacent uplands make this soil susceptible to erosion. Gullies form in unprotected drainageways. Sediments are deposited in some areas. The organic matter content is high. Capability unit IIe–3; environmental planting group 1.

Tuskeego series

The Tuskeego series consists of poorly drained soils on low benches and bottom lands. These soils formed in alluvial sediments under water-tolerant prairie grasses. Slopes are 0 to 1 percent.

In a representative profile the surface layer is very dark gray silt loam about 8 inches thick. The subsurface layer extends to a depth of 24 inches. It is dark gray silt loam in the upper part and dark grayish brown silty clay loam in the lower part. The subsoil is mottled dark grayish brown, firm silty clay in the upper 14 inches and mottled, grayish brown, firm silty clay loam to a depth of 65 inches.

Permeability is very slow, and available water capacity is high. Available phosphorus and potassium are very low in the subsoil.

Tuskeego soils are mainly farmed with the surrounding soils. Wetness is the main limitation.

Representative profile of Tuskeego silt loam, 0 to 1 percent slopes, in a cultivated field, 1,400 feet south and 400 feet west of the northeast corner of sec. 5, T. 79 N., R. 17 W.:

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, very dark grayish brown (10YR 3/2) kneaded; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A21—8 to 15 inches; dark gray (10YR 4/1) silt loam, dark grayish brown (10YR 4/2) kneaded, light gray (10YR 6/1 and 7/1) dry; few fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; weak thin platy structure; friable; medium acid; clear smooth boundary.

A22—15 to 24 inches; dark grayish brown (10YR 4/2) silty clay loam, same color kneaded, light gray (10YR 6/1 and 7/1) dry; few fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; weak thin platy and fine subangular blocky structure; friable; thin discontinuous light gray dry silt coats on faces of peds; medium acid; clear smooth boundary.

B21t—24 to 38 inches; dark grayish brown (10YR 4/2) light silty clay, light gray (10YR 6/1) and light brownish gray (10YR 6/2) dry; common fine distinct yellowish brown (10YR 5/6 and 5/8) and strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure parting to moderate medium subangular and angular blocky; firm; thin discontinuous clay films and silt coats on faces of peds; neutral; gradual smooth boundary.

B22tg—38 to 48 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine distinct yellowish brown (10YR 5/6 and 5/8) and strong brown (7.5Y 5/6) mottles; weak coarse prismatic structure parting to moderate subangular and angular blocky; firm; thin discontinuous clay films and silt coats on faces of peds; dark colored accumulations of oxides; neutral; gradual smooth boundary.

B3g—48 to 65 inches; grayish brown (2.5Y 5/2) silty clay loam, light gray (10YR 7/2) dry; many fine distinct and prominent yellowish brown (10YR 5/6 and 5/8) and strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure; firm; thin discontinuous silt coats on faces of peds; neutral.

The solum ranges from 48 inches to more than 60 inches in thickness. The A1 or Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The A2 horizon is dark gray (10YR 4/1), gray (10YR 5/1), dark grayish brown (10YR

4/2), or grayish brown (10YR 5/2). The upper part of the B2t horizon has a clay content of 40 to 48 percent. The lower part is typically grayish brown (2.5Y 5/2) but ranges to olive gray (5Y 5/2). It is silty clay loam or light silty clay.

Tuskeego soils are on bottom lands or low benches with other soils that formed in alluvium, such as Bremer, Colo, and Zook soils. Tuskeego soils have an A2 horizon, which those soils lack.

453—Tuskeego silt loam, 0 to 1 percent slopes. This soil is in slightly depressional areas on low benches and bottom lands. Areas are between 3 and 10 acres in size.

Included with this soil in mapping are some soils that have a black subsoil. Soils with a less clayey subsoil than this Tuskeego soil are included in a few places. Small ponded areas of less than 3 acres are indicated by a special symbol on the soil map.

Most areas of this soil are small and are commonly farmed with surrounding soils. Cultivated crops are grown in most places, but some of the wettest areas are left in pasture. This soil is moderately well suited to row crops. This soil usually is wet in spring. Because it dries slowly, tillage is delayed. Organic matter content is moderate. Capability unit IIIw–2; environmental planting group 2.

Wabash series

The Wabash series consists of very poorly drained soils on bottom lands. These soils formed in clayey alluvium under native grasses. Slope is 0 to 2 percent.

In a representative profile the surface layer is black silty clay 24 inches thick. The subsoil is black and very dark gray, firm silty clay in the upper 8 inches. Below this is very dark gray, firm silty clay to a depth of 50 inches. The substratum is dark gray and gray silty clay.

Permeability is very slow, and available water capacity is moderate. Available phosphorus in the subsoil is high, and available potassium is medium.

Wabash soils are mainly used for pasture, but drained areas are in cultivated crops. Wetness is a serious limitation.

Representative profile of Wabash silty clay, 0 to 2 percent slopes, in a pasture 500 feet west and 75 feet south of the center of sec. 30, T. 79 N., R. 19 W.:

A11—0 to 6 inches; black (N 2/0) silty clay; weak fine subangular blocky structure parting to weak fine granular; firm; slightly acid; gradual smooth boundary.

A12—6 to 17 inches; black (N 2/0) silty clay; moderate fine subangular blocky structure; firm; neutral; diffuse smooth boundary.

A13—17 to 24 inches; black (10YR 2/1) silty clay; moderate fine subangular blocky structure; firm; neutral; gradual smooth boundary.

B1g—24 to 32 inches; black (10YR 2/1) and very dark gray (10YR 3/1) silty clay; few fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure; firm; neutral; diffuse smooth boundary.

B2g—32 to 41 inches; very dark gray (10YR 3/1) silty clay; few fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; firm; neutral; diffuse smooth boundary.

B3g—41 to 50 inches; very dark gray (10YR 3/1) silty clay; few fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; firm; neutral; diffuse smooth boundary.

Cg—50 to 60 inches; dark gray (5Y 4/1) and gray (5Y 5/1) silty clay; common medium distinct yellowish brown (10YR 5/4 and 5/6) mottles; streaks of very dark gray (10YR 3/1); massive; firm; neutral.

The solum ranges from 40 inches to more than 60 inches in thickness. The A horizon is silty clay or heavy silty clay loam. It is 19 to 28 inches thick and ranges from medium acid to neutral. The B horizon is black (10YR 2/1) or very dark gray (2.5Y or 10YR 3/1) in the upper part and ranges from very dark gray (10YR or 2.5Y 3/1) to gray (10YR 5/1), grayish brown (2.5Y 5/2), or gray (5Y 5/1) in the lower part. It ranges from 46 to 60 percent clay and is slightly acid to mildly alkaline. The C horizon is silty clay or heavy silty clay loam and ranges from slightly acid to mildly alkaline.

Wabash soils are near Zook and Colo soils and formed in the same kind of parent material as those soils. Wabash soils are more clayey than Zook and Colo soils.

172—Wabash silty clay, 0 to 2 percent slopes. This soil is on broad flood plains of major streams. Most areas are large.

Included with this soil in mapping are Wabash soils with a silty clay loam surface layer and marsh areas less than 2 acres in size. Ponded areas are indicated by a special symbol on the soil map.

This soil is used for cultivated crops, hay, and pasture. It is moderately well suited to row crops if adequately drained. It is susceptible to overflow from nearby streams and to prolonged ponding after rains. Maintaining good tilth is difficult because of the clayey surface layer and the restricted drainage. Organic matter content is high. Capability unit IIIw–1; environmental planting group 2.

Webster series

The Webster series consists of poorly drained soils on uplands. These soils formed in glacial till and local alluvium under grass. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black silty clay loam about 17 inches thick. The subsoil is friable silty clay loam that extends to a depth of 47 inches; the upper few inches is very dark gray, and the lower part is olive gray and has yellowish brown mottles. The substratum is olive gray and light olive gray loam.

Permeability is moderate to moderately slow, and available water capacity is high. Available phosphorus and potassium are very low in the subsoil.

Webster soils are mainly used for corn and soybeans. Wetness is the major limitation.

Representative profile of Webster silty clay loam, 0 to 2 percent slopes, in a cultivated field, in the northwest corner of the SW¼SW¼ sec. 6, T. 81 N., R. 21 W.:

Ap—0 to 6 inches; black (N 2/0) silty clay loam; moderate fine subangular blocky and granular structure; friable; neutral; abrupt smooth boundary.

A12—6 to 10 inches; black (N 2/0) silty clay loam; weak coarse prismatic structure parting to weak fine subangular blocky; friable; neutral; gradual smooth boundary.

A13—10 to 17 inches; black (N 2/0) silty clay loam that has a high content of sand; moderate fine subangular blocky structure; friable; neutral; gradual smooth boundary.

B1g—17 to 20 inches; very dark gray (5Y 3/1) silty clay loam that has a high content of sand; many fine faint olive gray (5Y 4/2) mottles; moderate fine subangular blocky structure; friable; neutral; clear wavy boundary.

B2g—20 to 47 inches; olive gray (5Y 5/2) and light olive gray (5Y 6/2) silty clay loam that has a high content of sand; few fine distinct yellowish brown mottles; weak fine subangular blocky structure; friable; few calcium carbonate precipitates; neutral; gradual smooth boundary.

Cg—47 to 60 inches; olive gray (5Y 5/2) and light olive gray (5Y 6/2) loam; many fine distinct and prominent yellowish brown mottles; massive; friable; few calcium carbonate precipitates; neutral.

The thickness of the solum and the depth to carbonates range from 30 to 50 inches. The A horizon is generally black (N 2/0) but ranges to very dark gray (10YR 3/1). This horizon is typically silty clay loam but ranges to light clay loam. The B1 horizon is commonly very dark gray (5Y 3/1), dark gray (5Y 4/1), or olive gray (5Y 4/2). The B2 horizon is typically olive gray (5Y 5/2 or 4/2) and light olive gray (5Y 6/2) silty clay loam or clay loam. The C horizon is generally loam or is somewhat stratified and contains lenses of silt, sandy loam, or loamy sand.

Webster soils formed in parent material similar to those of Canisteo soils. Webster soils are not calcareous throughout their profile as are Canisteo soils.

107—Webster silty clay loam, 0 to 2 percent slopes. This soil typically is in concave swales or on broad smooth areas. Areas in swales are commonly long and narrow. Areas are from about 10 acres to 50 acres or more in size.

Included with this soil in mapping are wetter and finer textured soils in small depressions. These soils are indicated by a special symbol on the soil map. Also included are some areas of Canisteo soils.

This soil is well suited to row crops, and this is its main use. Tile and open ditches drain almost all areas. Timely field operations are important in maintaining good tilth. Fall plowing is a common practice, but it increases the hazard of soil blowing. Capability unit IIw–3; environmental planting group 2.

Wiota series

The Wiota series consists of well drained to moderately well drained soils on benches. These soils formed in silty alluvium under tall prairie grasses. Slope is 0 to 2 percent.

In a representative profile the surface layer is black silt loam in the upper 8 inches and very dark gray, very dark grayish brown and brown silty clay loam in the lower 12 inches. The subsoil extends to a depth of 46 inches and is brown friable silty clay loam. The substratum is brown silty clay loam.

Permeability is moderate, and available water capacity is high. Available phosphorus in the subsoil is very low, and available potassium is low.

Wiota soils are mainly used for cultivated crops. There are no serious limitations.

Representative profile of Wiota silt loam, 0 to 2 percent slopes, in a cultivated field, 400 feet north and 200 feet east of the southwest corner of SE¼NW¼ sec. 11, T. 79 N., R. 20 W.:

Ap—0 to 8 inches; black (10YR 2/1) silt loam; weak very fine granular structure; friable; neutral; gradual smooth boundary.

A12—8 to 14 inches; very dark gray (10YR 3/1) silty clay loam, very dark grayish brown (10YR 3/2) kneaded; moderate very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A3—14 to 20 inches; very dark grayish brown (10YR 3/2) and brown (10YR 4/3) silty clay loam, very dark grayish brown (10YR 3/2) kneaded; thin discontinuous dark brown (10YR 3/3) coats; moderate very fine and fine subangular blocky structure; friable; slightly acid; clear, smooth boundary.

B21t—20 to 29 inches; brown (10YR 4/3) silty clay loam; weak fine subangular blocky structure; friable; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B22t—29 to 38 inches; brown (10YR 4/3) silty clay loam; thin discontinuous dark brown (10YR 3/3) coats; weak fine subangular blocky structure; friable; few discontinuous clay films; slightly acid; gradual smooth boundary.

B3—38 to 46 inches; brown (10YR 4/3) silty clay loam, light yellowish brown (10YR 6/4) dry; few fine faint yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; medium acid; gradual smooth boundary.

C—46 to 60 inches; brown (10YR 4/3) silty clay loam; few fine faint grayish brown (2.5Y 5/2) and few fine faint yellowish brown

(10YR 5/4) mottles; massive; friable; medium acid.

The solum ranges from 36 to 60 inches in thickness. The A horizon is 18 to 30 inches thick. It is silt loam or silty clay loam and is slightly acid or neutral. The B horizon is 15 to 26 inches thick and ranges from slightly acid to medium acid.

Wiota soils are on stream benches with Bremer and Nevin soils and formed in somewhat similar materials. They are slightly higher on the landscape than the somewhat poorly drained Nevin soil and the finer textured, poorly drained Bremer soils.

7—Wiota silt loam, 0 to 2 percent slopes. This Wiota soil is typically on low stream benches only a few feet above the flood plain. Areas are irregular in shape and 3 to 25 acres in size.

Included with this soil in mapping are small areas of somewhat poorly drained Nevin and poorly drained Bremer soils.

This soil is used for cultivated crops. It is well suited to row crops. There are no serious limitations. Some low-lying areas flood infrequently. Capability unit I–1; environmental planting group 1.

Zook series

The Zook series consists of poorly drained soils that formed in alluvium on bottom lands. Native vegetation was grass. Slope is 0 to 2 percent.

In a representative profile the surface layer is black and is about 37 inches thick; it is silty clay loam in the upper part and silty clay in the lower part. The subsoil is black and very dark gray, firm silty clay to a depth of 55 inches. The substratum is gray silty clay.

Permeability is slow, and available water capacity is high. Available phosphorus in the subsoil is low, and available potassium is very low.

Zook soils are mainly used for cultivated crops if drainage is adequate. Wetness and flooding are hazards.

Representative profile of Zook silty clay loam, 0 to 2 percent slopes, in a cultivated field, 250 feet west and 40 feet south from the northeast corner of NW¼NE¼ sec. 29, T. 79 N., R 19 W.:

Ap—0 to 7 inches; black (N 2/0) medium silty clay loam; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A12—7 to 14 inches; black (N 2/0) heavy silty clay loam; moderate very fine subangular blocky structure; friable; slightly acid; diffuse smooth boundary.

A13—14 to 20 inches; black (N 2/0) light silty clay; moderate very fine and fine subangular blocky structure; firm; slightly acid; diffuse smooth boundary.

A3—20 to 37 inches; black (N 2/0) light silty clay; moderate fine angular and subangular blocky structure; firm; slightly acid; diffuse smooth boundary.

B21g—37 to 43 inches; black (10YR 2/1) light silty clay; moderate medium subangular blocky structure; firm; slightly acid; gradual smooth boundary.

B22g—43 to 55 inches; very dark gray (10YR 3/1) light silty clay; moderate medium subangular blocky structure; firm; slightly acid; clear smooth boundary.

Cg—55 to 60 inches; gray (5Y 4/1) light silty clay; many fine prominent yellowish brown (10YR 5/6) mottles; massive; firm; neutral.

The solum ranges from 36 to 64 inches in thickness. It is slightly acid to mildly alkaline. The A horizon is mainly black (N 2/0 or 10YR 2/1), but colors 3 or less in value extend to a depth of 36 inches or more. The A horizon is silty clay loam or light silty clay. The B horizon is very dark gray (10YR 3/1), black (10YR 2/1), dark gray (10YR to 5Y 4/1), or gray (5Y 5/1). Mottles high in chroma are in some pedons.

Zook soils are on bottom lands with and formed in the same kind of parent material as Colo and Wabash soils. Zook soils are finer textured than Colo soils and coarser textured than Wabash soils.

54—Zook silty clay loam, 0 to 2 percent slopes. This soil is on bottom lands along the major streams. Areas are typically large and are irregular in shape.

Included with this soil in mapping are small depressions and sandy areas. These areas are indicated by a special symbol on the soil map.

This soil is planted mainly to corn and soybeans where drainage is adequate and flooding is controlled (fig. 13). This soil is well suited to row crops, but artificial drainage is important. Maintaining good tilth is a problem. Organic matter content is high. Capability unit IIw–2; environmental planting group 2.

Use and management of the soils

The soil survey is a detailed analysis and evaluation of the most basic resource of the survey area—the soil. It may be used to fit the use of the land, including urbanization, to the limitations and potentials of the natural resources and the environment and to help avoid soil-related failures in uses of the land.

Figure 13.—**An area of Zook silty clay loam, 0 to 2 percent slopes. Wetness and flooding are limitations on Zook soils.**

During a soil survey soil scientists, conservationists, engineers, and others keep extensive notes, not only about the nature of the soils but also about unique aspects of behavior of these soils in the field and at construction sites. These notes include observations of erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic systems, and other factors relating the kinds of soil and their productivity, potentials, and limitations under various uses and management. In this way field experience incorporated with measured data on soil properties and performance is used as a basis for predicting soil behavior.

Information in this section will be useful in applying basic facts about the soils to plans and decisions for use and management of soils for crops and pasture, woodland, and many nonfarm uses, including building sites, highways and other transportation systems, sanitary facilities, parks and other recreational developments, and wildlife habitat. From the data presented, the potential of each soil for specified land uses may be determined, soil limitations to these land uses may be identified, and costly failures in homes and other structures, because of unfavorable soil properties, may be avoided. A site can be selected where the soil properties are favorable, or practices can be planned that will overcome the soil limitations.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area, and on the environment. Both productivity and environment are closely related to the nature of the soil. Plans can be made to maintain or create a land use pattern in harmony with the natural soil.

Contractors can find information useful in locating sources of sand and gravel, road fill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, trees and shrubs, and most other uses of land are influenced by the nature of the soil.

Crops and pasture

Approximately 80 percent of Jasper County is in crops and pasture. Corn is the major crop. Soybeans, oats, and hay are also planted extensively. Sorghum, wheat, rye, and other minor crops total only about 1,000 acres in most years.

Some of the soil properties that affect management and some of the common practices used to improve productivity and protect the soil are discussed in this section. Predicted yields are given for the principal crops grown in Jasper County. There is also an explanation of the system of capability classification used by the Soil Conservation Service, and management by capability units is discussed.

Factors that affect management

Farmers must know the character of the soil and its limitations and other factors if they are to make a successful plan for controlling erosion, improving the soil, selecting crops, and maintaining good yields. The suitability of a soil for certain plants and the management needed depend on drainage, permeability, texture, slope, organic matter content, and other soil characteristics given in the descriptions of the soil series and mapping units. Some of these characteristics, as defined by soil scientists, are given in the Glossary.

Crops.—Controlling runoff and erosion is an important consideration of management on all of the sloping soils of the county. Removing excess water is necessary on many of the nearly level soils and on a few of the sloping soils. Protecting the soils in the valleys from flooding and from run-on water from the adjoining upland soils is another common problem of management. Fertility and good tilth must be maintained on all soils. Common practices used in the county are discussed in the following paragraphs.

Contour tillage and other tillage methods that leave crop residue on the surface are valuable in controlling runoff and erosion. Cropping systems that include grasses and legumes are also helpful. Other measures used to control erosion are terraces, diversions, grassed waterways, and ponds.

Most of the terraces in Jasper County are built on soils that formed in loess. In general, these are the main soils used for cultivated crops. They also have a subsoil that when exposed, can be raised to reasonable levels of productivity over a period of a few years by large applications of manure and fertilizer. This is especially true of soils such as Tama, Downs, and Fayette soils, which have a less clayey subsoil than most other soils of the county. Stockpiling topsoil during construction and spreading it over the areas of exposed subsoil is a good practice on all soils. It is essential on soils such as Bauer, Adair, Clarinda, and Lamoni soils.

Diversions are used to protect soils on bottom lands and foot slopes from being flooded by runoff from the adjoining hillsides. Many of the soils on bottom lands, such as Colo, Zook, and Wabash soils, are poorly drained or very poorly drained. Run-on from upslope increases the problem of disposing of excess water. In addition, rilling and gullying occur on Judson, Olmitz, Ely, Martinsburg, and other soils on foot slopes if this run-on is not intercepted. Sedimentation is another hazard. Young plants are sometimes buried and killed by silt washed off the hillsides.

Grassed waterways help to prevent gullies from forming in watercourses. The major soils on which waterways are built are in the Colo, Ely, Ackmore, Judson, and Zook series. These soils support good plant growth if they are properly drained and fertilized. Lines of tile generally are used to reduce wetness. Grassed waterways are not needed in fields where terraces with tile inlets have been installed.

Farm ponds help to prevent gully erosion, keep excess water off bottom lands, and provide water for

livestock. These ponds hold water behind an earth dam. They also are used for recreation and for farm water supplies. Most of the ponds are in areas of Adair, Bauer, Clarinda, Gara, Lamoni, Lindley, and Shelby soils. These soils and the material derived from them for construction of dams generally are relatively impervious. Onsite investigation is needed to avoid pockets of sand or other porous materials.

Maintaining fertility and good tilth is another consideration in management. Including grasses and legumes in the cropping system is one method commonly used in this county. Applying manure, crop residue, and commercial fertilizers is also common.

The soils on the bottom lands generally can be used intensely for row crops if drainage is adequate and if flooding is controlled. Flooding is most common from March to June. Floods that occur later in spring, after the crops are planted, are the most damaging. Building levees, improving stream channels, and installing conservation practices upstream are methods commonly used to control flooding.

Rainfall is adequate in most years for the crops generally grown in the county. The distribution of rainfall during the growing season is seldom ideal, so supplemental irrigation can improve yields. The cost of an irrigation system, the availability of an adequate water supply, and other factors must be considered. Irrigation has been a very minor practice in Jasper County.

Many soils in the county need artificial drainage to improve timeliness of operations and to increase production. Upland soils that benefit from tile drainage include Canisteo, Garwin, Taintor, and Sperry soils. In addition, tile drainage systems often are installed in soils of the Atterberry, Muscatine, Nicollet, and Mahaska series to improve timeliness of operations. Tile drains installed in Sperry soils do not function adequately in places, and surface drains are needed to remove ponded water. Interceptor tile help to prevent side-hill seeps in some of the sloping soils that formed in loess. These soils are in the Clinton, Ladoga, Nira, and Otley series. The interceptor tile are placed at the contact line between these soils and soils of the Adair, Armstrong, Clarinda, and Lamoni series, which lie downslope.

Bottom land soils that benefit from tile drains are in the Bremer, Colo, Nevin, Ackmore, Tuskeego, and Zook series. Tile drains in Wabash soils, and in places in Zook and Tuskeego soils, do not function adequately, so surface drains are needed. Suitable outlets for surface drains and tile are available in most places, but some low-lying areas lack good outlets.

Pasture.—Most of the pasture in the county is on strongly sloping to very steep soils. Some is on soils on bottom lands that are frequently flooded.

Establishing and maintaining desirable plant species is the main consideration in management. Management includes controlling woody plants that readily invade pastures. Farm machinery can be used on most of the pastures, so reseeding, fertilizing, and other cultural practices are practical. Overgrazing increases the hazard of erosion and encourages the invasion of weeds.

Most woodlands in the county are mainly used for grazing, rather than for wood products. Production from these pastures is quite limited.

Yield predictions

In table 2 the average yields per acre of the principal crops that can be expected under a high level of management are predicted for soils of Jasper County. Under this level of management, seedbed preparation, planting, and tillage practices provide for adequate stands of adapted varieties; erosion is controlled; the organic matter content and soil tilth are maintained; the level of fertility for each crop is maintained as indicated by soil tests and field trails; the water level in wet soils is controlled; weed and pest control is excellent; and farm operations are timely.

Sources of yield information were data from the Federal census and the Iowa farm census, data from experimental farms and cooperative experiments with farmers, and data from on-farm experience by soil scientists, extension workers, and others.

The yield predictions serve as guides. They are and should be considered approximate values only. Of more value than actual yield figures to many users are the comparative yields of various soils. These relationships are likely to remain constant over a period of years. Actual yields, however, have been increasing in recent years. If they continue to increase as expected, predicted yields in this table will soon be too low.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for forest trees or engineering.

In the capability system, all kinds of soils are grouped at three levels: the capability class, the subclass, and the unit. These levels are discussed in the following paragraphs:

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce

TABLE 2.—*Predicted average yields per acre of principal crops under a high level of management*

[Absence of a figure indicates that the crop is not suited to the soil or is not generally grown on it]

Soil	Corn	Soybeans	Oats	Alfalfa-bromegrass	Bromegrass pasture
	Bu	*Bu*	*Bu*	*Tons*	*AUD* [1]
Ackmore silt loam, 0 to 2 percent slopes	106	40	73	4.5	190
Ackmore-Colo complex, 2 to 5 percent slopes [2]	105	40	73	4.3	175
Ackmore-Colo complex, channeled, 2 to 5 percent slopes [2]				4.0	120
Adair clay loam, 9 to 14 percent slopes, moderately eroded	54	20	30	2.3	85
Alluvial land, channeled [2]				4.0	70
Alluvial land-Nodaway complex, 0 to 2 percent slopes [2]	100	38	60	4.0	80
Armstrong loam, 9 to 14 percent slopes, moderately eroded	50	19	28	2.0	80
Atterberry silt loam, 0 to 2 percent slopes	125	47	93	5.0	225
Bauer silt loam, 9 to 18 percent slopes, moderately eroded				2.5	70
Bauer silt loam, 18 to 40 percent slopes, moderately eroded				1.5	60
Bolan loam, 0 to 2 percent slopes	90	34	72	3.8	160
Bremer silty clay loam, 0 to 2 percent slopes	106	40	58	4.5	170
Caleb and Mystic soils, 9 to 14 percent slopes, moderately eroded	60	22	33	2.5	100
Caleb and Mystic soils, 14 to 18 percent slopes, moderately eroded				1.7	80
Canisteo clay loam, 0 to 2 percent slopes	105	40	84	4.2	170
Chelsea loamy fine sand, 4 to 9 percent slopes	50	19	37	1.8	90
Chelsea loamy fine sand, 9 to 14 percent slopes				1.5	80
Chelsea loamy fine sand, 14 to 25 percent slopes				1.2	60
Chelsea-Fayette complex, 25 to 40 percent slopes				1.5	80
Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded	55	21	30	2.2	100
Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	46	17	25	1.8	85
Clarion loam, 2 to 5 percent slopes	110	42	88	4.6	200
Clarion loam, 5 to 9 percent slopes, moderately eroded	102	39	82	4.3	185
Clarion loam, 9 to 14 percent slopes, moderately eroded	93	35	74	3.9	165
Clarion loam, 14 to 18 percent slopes, moderately eroded	78	30	60	3.3	140
Clinton silt loam, 5 to 9 percent slopes, moderately eroded	99	38	54	4.2	180
Clinton silt loam, 9 to 14 percent slopes, moderately eroded	90	34	50	3.8	160
Clinton silt loam, 14 to 18 percent slopes, moderately eroded	75	29	41	3.2	135
Clinton soils, 9 to 14 percent slopes, severely eroded	80	31	44	3.4	145
Coland clay loam, 0 to 2 percent slopes [2]	100	38	80	4.2	170
Coland clay loam, 2 to 5 percent slopes [2]	98	37	78	4.1	125
Colo silty clay loam, 0 to 2 percent slopes [2]	104	40	72	4.2	125
Colo silt loam, overwash, 0 to 2 percent slopes [2]	106	42	73	4.3	125
Dickinson fine sandy loam, 2 to 5 percent slopes	81	31	60	3.0	145
Dickinson fine sandy loam, 5 to 9 percent slopes	76	29	57	2.8	135
Dickinson fine sandy loam, 9 to 14 percent slopes	67	25	50	2.3	120
Downs silt loam, 0 to 2 percent slopes	125	47	95	5.0	220
Downs silt loam, 2 to 5 percent slopes	119	45	95	5.0	215
Downs silt loam, 5 to 9 percent slopes, moderately eroded	111	42	89	4.7	200
Downs silt loam, 9 to 14 percent slopes, moderately eroded	102	39	82	4.3	185
Downs silt loam, 14 to 18 percent slopes, moderately eroded	87	33	69	3.7	155
Downs silt loam, benches, 2 to 5 percent slopes	119	45	95	5.0	215
Downs silt loam, benches, 5 to 9 percent slopes	111	42	89	4.7	200
Ely silty clay loam, 2 to 5 percent slopes	124	47	93	5.3	225
Fayette silt loam, 2 to 5 percent slopes	113	43	90	4.7	200
Fayette silt loam, 5 to 9 percent slopes, moderately eroded	105	40	84	4.4	190
Fayette silt loam, 9 to 14 percent slopes, moderately eroded	96	36	76	4.0	170
Fayette silt loam, 14 to 18 percent slopes, moderately eroded	81	31	65	3.4	145
Fayette silt loam, 18 to 25 percent slopes, moderately eroded				3.2	135
Fayette soils, 9 to 14 percent slopes, severely eroded	90	34	72	3.8	160
Flagler sandy loam, 1 to 4 percent slopes	61	23	46	2.5	110

TABLE 2.—*Predicted average yields per acre of principal crops under a high level of management*—Continued

Soil	Corn	Soybeans	Oats	Alfalfa-bromegrass	Bromegrass pasture
	Bu	*Bu*	*Bu*	*Tons*	*AUD* [1]
Gara loam, 9 to 14 percent slopes, moderately eroded	75	28	41	3.1	135
Gara loam, 14 to 18 percent slopes, moderately eroded				2.2	45
Gara loam, 18 to 25 percent slopes, moderately eroded				1.5	40
Gara loam, 25 to 40 percent slopes				1.2	40
Gara-Armstrong loams, 9 to 14 percent slopes, moderately eroded	69	26	38	2.8	115
Gara-Armstrong loams, 14 to 18 percent slopes, moderately eroded				2.4	90
Gara-Armstrong complex, 14 to 18 percent slopes, severely eroded				2.0	75
Garwin silty clay loam, 0 to 2 percent slopes	125	47	94	5.0	205
Garwin-Sperry complex, 0 to 2 percent slopes	118	46	84	2.9	197
Hayden loam, 14 to 18 percent slopes, moderately eroded				2.7	115
Hayden loam, 18 to 25 percent slopes					75
Hayden loam, 25 to 40 percent slopes					30
Judson silt loam, 0 to 2 percent slopes	125	48	93	5.2	225
Judson silty clay loam, 2 to 5 percent slopes	124	47	93	5.2	225
Judson silty clay loam, 5 to 9 percent slopes	119	45	90	5.0	215
Kennebec silt loam, 0 to 2 percent slopes	124	47	93	5.2	225
Killduff silty clay loam, 5 to 9 percent slopes, moderately eroded	114	41	85	4.7	200
Killduff silty clay loam, 9 to 14 percent slopes, moderately eroded	105	38	77	4.3	180
Killduff silty clay loam, 14 to 18 percent slopes, moderately eroded	89	35	69	3.9	160
Ladoga silt loam, 2 to 5 percent slopes	113	43	62	4.7	205
Ladoga silt loam, 5 to 9 percent slopes, moderately eroded	105	40	57	4.4	190
Ladoga silt loam, 9 to 14 percent slopes, moderately eroded	96	36	53	4.0	175
Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded	61	23	33	2.6	110
Lamoni silty clay loam, 14 to 18 percent slopes, moderately eroded				1.7	45
Lawler loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes	100	38	80	4.2	180
Lawler loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	85	32	68	3.6	155
Lester loam, 2 to 5 percent slopes	104	40	83	4.4	185
Lester loam, 5 to 9 percent slopes, moderately eroded	92	35	74	3.9	165
Lester loam, 9 to 14 percent slopes, moderately eroded	83	32	66	3.5	150
Lindley loam, 14 to 18 percent slopes				2.0	85
Lindley loam, 18 to 25 percent slopes				1.2	60
Lindley loam, 25 to 40 percent slopes				1.0	50
Lindley soils, 14 to 18 percent slopes, severely eroded				1.5	70
Mahaska silty clay loam, 0 to 2 percent slopes	125	48	69	5.2	225
Marsh					
Martinsburg silt loam, 2 to 5 percent slopes	112	42	62	4.7	210
Martinsburg silt loam, 5 to 9 percent slopes	107	41	59	4.5	195
Muscatine silty clay loam, 0 to 2 percent slopes	131	50	98	5.5	235
Nevin silty clay loam, 0 to 2 percent slopes	114	43	63	4.8	205
Nicollet loam, 1 to 3 percent slopes	118	45	94	5.0	210
Nira silty clay loam, 2 to 5 percent slopes, moderately eroded	111	42	61	4.7	200
Nira silty clay loam, 5 to 9 percent slopes, moderately eroded	106	40	58	4.5	190
Nira silty clay loam, 9 to 14 percent slopes, moderately eroded	97	36	53	4.1	175
Nodaway silt loam, 0 to 2 percent slopes [2]	114	43	63	4.8	205
Olmitz loam, 2 to 5 percent slopes	100	38	55	4.2	180
Olmitz loam, 5 to 9 percent slopes	95	36	52	4.0	170
Otley silty clay loam, 2 to 5 percent slopes	119	54	65	5.0	215
Otley silty clay loam, 5 to 9 percent slopes, moderately eroded	111	42	61	4.7	200
Otley silty clay loam, 9 to 14 percent slopes, moderately eroded	102	39	56	4.3	185
Port Byron silt loam, 5 to 9 percent slopes, moderately eroded	117	44	88	4.9	210
Port Byron silt loam, 9 to 14 percent slopes, moderately eroded	108	41	81	4.5	190

TABLE 2.—*Predicted average yields per acre of principal crops under a high level of management*—Continued

Soil	Corn	Soybeans	Oats	Alfalfa-bromegrass	Bromegrass pasture
	Bu	*Bu*	*Bu*	*Tons*	*AUD*[1]
Port Byron silt loam, 14 to 18 percent slopes, moderately eroded	93	35	74	3.9	165
Port Byron silt loam, 18 to 25 percent slopes, moderately eroded				3.3	140
Shelby loam, 9 to 14 percent slopes, moderately eroded	81	31	44	3.4	145
Shelby loam, 14 to 18 percent slopes, moderately eroded	66	25	36	2.7	120
Shelby loam, 18 to 25 percent slopes, moderately eroded					50
Shelby-Adair complex, 9 to 14 percent slopes, moderately eroded	72	27	40	3.0	125
Shelby-Adair complex, 14 to 18 percent slopes, moderately eroded				2.5	100
Sparta loamy fine sand, 1 to 5 percent slopes	61	23	45	2.6	105
Sparta loamy fine sand, 5 to 9 percent slopes, moderately eroded	54	21	40	2.3	95
Sparta loamy fine sand, 9 to 18 percent slopes, moderately eroded				2.1	85
Sperry silt loam, 0 to 1 percent slopes	97	37	53	3.5	155
Storden loam, 5 to 14 percent slopes	83	32	66	3.5	150
Storden loam, 14 to 18 percent slopes	68	26	54	2.9	120
Storden loam, 18 to 25 percent slopes				2.2	105
Taintor silty clay loam, 0 to 2 percent slopes	117	44	64	4.7	190
Tama silty clay loam, 0 to 2 percent slopes	130	49	96	5.3	235
Tama silty clay loam, 2 to 5 percent slopes	125	48	95	5.2	225
Tama silty clay loam, 5 to 9 percent slopes, moderately eroded	117	44	88	4.9	210
Tama silty clay loam, 9 to 14 percent slopes, moderately eroded	108	41	81	4.5	190
Tama silty clay loam, benches, 2 to 5 percent slopes	125	48	95	5.2	225
Tama silty clay loam, benches, 5 to 9 percent slopes	117	44	88	4.9	210
Terril loam, 2 to 5 percent slopes	118	45	89	5.0	210
Tuskeego silt loam, 0 to 1 percent slopes	82	31	45	3.3	130
Wabash silty clay, 0 to 2 percent slopes	68	26	37	1.8	100
Webster silty clay loam, 0 to 2 percent slopes	110	42	88	4.4	200
Wiota silt loam, 0 to 2 percent slopes	110	42	62	4.6	200
Zook silty clay loam, 0 to 2 percent slopes	96	36	72	4.0	120

[1] Animal-unit-days (AUD) is a term used to express the carrying capacity of pasture. It is the number of animal units carried per acre multiplied by the number of days the pasture can be grazed during a single season without injury to the sod. The predictions assume that one mature animal will consume 40 pounds of dry matter per pasture-day.

[2] Yields on these soils vary because of flooding.

the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife habitat.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes (No Class VIII soils are in Jasper County.).

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c,* used in some parts of the United States but not in Iowa, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w, s,* and *c,* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants,

to require similar management and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are designated by adding an Arabic numeral to the subclass symbol, for example, IIe–4 or IIIe–6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Jasper County are described and suggestions for the use and management of the soils are given.

Capability unit I–1

This unit consists of nearly level, well drained, moderately well drained, or somewhat poorly drained soils on upland, stream benches, or bottom lands.

The surface layer is silt loam, loam, or silty clay loam. Permeability in most of the soils is moderate, but in some it is moderately slow. Available water capacity is high. The organic matter content is high in most of the soils, but in some it is moderate. Typically, the surface layer is slightly acid, but it ranges from neutral to medium acid, depending partly on liming practices.

These soils are used intensively for row crops, and they are well suited to this use. They have no serious limitations. The soils on the bottom lands and on some of the low-lying benches are susceptible to flooding. Except on some of the lowest elevations, however, flooding is not so frequent as to seriously hinder the use of the soils for row crops. The somewhat poorly drained soils have a seasonal water table at a depth as little as 2 to 3 feet. Tile has been installed in some areas to reduce the time needed for the soils to dry enough to permit field operations.

Good management practices are especially suitable on these soils. High plant populations, high rates of fertilization, good control of weeds and insects, and efficient use of crop residue normally produce favorable returns.

Capability unit IIe–1

This unit consists of gently sloping, well drained soils on uplands.

The surface layer is loam. Permeability is moderate, and available water capacity is high. The organic matter content is moderate or low. Typically, the surface layer is slightly acid or neutral.

These soils are used intensively for row crops, and they are well suited to this use. Erosion is a hazard, and soil blowing is a limitation in places.

Many areas of these soils are small convex knobs surrounded by soils with restricted drainage, that are not subject to erosion. Contour tillage and other conservation practices that follow the contour of the land are difficult on these knobs. Tillage methods that leave crop residue on the surface are more practical in controlling erosion on many of the areas. Applying extra manure and fertilizer also is helpful. These practices also help to control soil blowing.

Where the soils of this unit are farmed with soils that are moderately sloping or strongly sloping, they are usually planted to small grain and grass-legume crops in some years. Tilling on the contour, terracing, and stripcropping can be used more often in these soils than on the knobby landscapes.

A few areas of this unit are associated with moderately steep to very steep soils. In some of these areas, the soils are used for pasture or timber, although most areas are accessible and could be used for cultivated crops. If the areas are left in grass or trees, they are extremely well suited to intensive management.

Capability unit IIe–2

This unit consists of gently sloping, well drained and moderately well drained soils on uplands and high stream benches.

Their surface layer is silt loam or silty clay loam. Permeability is moderate or moderately slow, and available water capacity is high. Organic matter content ranges from low to high. The surface layer is neutral to medium acid, depending on liming practices. On benches, these soils typically lie between moderately sloping or strongly sloping soils on side slopes on the uplands and nearly level soils on the bottom lands.

These soils are used intensively for row crops, and they are well suited to this use. Erosion is a hazard.

Typically the soils on the uplands are between nearly level soils on broad divides and moderately or strongly sloping soils downslope. The nearly level to moderately or strongly sloping soils are farmed together in most places. The gently sloping soils of this unit make up about half or less of an individual field, and either the nearly level soils or the moderately or strongly sloping soils make up a large part of the remainder. Intensive row cropping and farming in straight rows is common in areas where the nearly level soils are dominant. Controlling erosion is important. Efficient use of crop residue and manure is needed, especially on soils that have low organic matter content.

Next to the moderately or strongly sloping soils, practices that control erosion on those soils can be used on the soils of this unit. Practices that follow the contour of the land can generally be used in these areas.

Capability unit IIe–3

This unit consists of gently sloping, well drained or moderately well drained soils on foot slopes and alluvial fans.

The surface layers are loam, silt loam, or silty clay loam. Permeability is moderate, and available water capacity is high. Organic matter content is high except in one soil, where it is low. Typically the surface layer is slightly acid or medium acid, depending on liming practices.

Most areas of these soils are used intensively for row crops, but some inaccessible areas are in pasture or are wooded. The soils are well suited to row crops. Erosion is a hazard. Excess runoff from the adjoining uplands washes over these soils, causing sheet erosion, rilling and gullying, siltation, and wetness.

Diversion terraces and conservation practices on hillsides help to keep runoff water off these soils. Grassed waterways help prevent the formation and

growth of gullies. Tilling on the contour reduces rilling.

Capability unit IIs–1

This unit consists of nearly level and gently sloping soils on stream benches. The soils are somewhat excessively drained, well drained, or somewhat poorly drained.

The surface layer is loam or sandy loam. Permeability is moderate or moderately rapid. The permeability of the substratum is rapid in all of the soils. The available water capacity is moderate, and organic matter content ranges from moderate to high. The surface layer is slightly acid to strongly acid if not limed.

These soils are used intensively for row crops and are well suited to this use, but they are susceptible to drought. Soil blowing is also a hazard. These soils warm up early in spring and most can be worked soon after rains. They have good tilth and are easy to work. The somewhat poorly drained soils have a seasonal high water table that slows drying of the surface layer during wet seasons. Root growth is restricted to some extent by underlying sand or gravel.

Good management practices are needed to control soil blowing and conserve moisture. Using crop residue and manure on the surface is helpful. Disking in strips crosswise to the direction of the wind gives some protection against soil blowing on bare fields.

Capability unit IIw–1

This unit consists of gently sloping, somewhat poorly drained or poorly drained soils along drainageways, on foot slopes and on alluvial fans.

The surface layer is silt loam, silty clay loam, or clay loam. Permeability is moderate or moderately slow. Available water capacity is high. The organic matter content is high except in one soil, where it is moderate. The surface layer is medium acid to neutral if not limed.

These soils are farmed with adjoining soils. They are well suited to row crops, and they are mainly used for this purpose if the adjoining soils also are suited. Excess runoff from upslope washes over these soils, causing sheet erosion, gullying and rilling, siltation, and wetness.

Grassed waterways are needed on some of these soils. Diversions help to control runoff from nearby slopes and prevent siltation. These soils tend to dry out slowly in the spring. Properly installed drainage systems, tile or surface drainage type, improve many areas. Erosion control structures are needed in places, in addition to grassed waterways, to prevent gullies from forming at tile outlets.

Capability unit IIw–2

This unit consists of nearly level soils on first and second bottom lands or low stream benches. The soils are mostly poorly drained. Some of the soils are somewhat poorly drained or moderately well drained.

The surface layer is silt loam, silty clay loam, or clay loam. Permeability is moderate to slow. Available water capacity is high. Organic matter content is high in most of the soils. In one soil it is low and in another it is low to moderate. The surface layer is neutral or slightly acid.

These soils are used intensively for row crops, and they are well suited to this use. Crops respond well to good management. Flooding is a hazard, but it does not generally make intensive cultivation impractical. Wetness is also a hazard.

These soils can be drained by tile if suitable outlets are available. Surface drains improve many low areas. Diversions, levees or dikes, and channel improvements control flooding and the runoff from higher areas. Erosion control practices on the adjoining uplands reduce siltation and wetness. Artificial drainage improves timeliness of operations, which is needed to maintain good tilth, especially on soils that have a silty clay loam surface layer.

Capability unit IIw–3

This unit consists of nearly level soils on uplands. The soils are mainly poorly drained, but one of them is poorly drained to very poorly drained.

The surface layer is mainly silty clay loam but is silt loam in some of the soils. Permeability is moderate to very slow. Available water capacity is high. Organic matter content is high except in one soil where it is moderate to high. The surface layer is medium acid to mildly alkaline.

These soils are well suited to row crops if they are adequately drained. Crops respond well to good management. The soils are wet. Some soils are subject to ponding because they receive water from adjoining soils.

These soils generally are farmed with drier soils. Tilth is good but the surface layer puddles if worked when wet. Artificial drainage is needed. Restricted drainage delays planting and causes crops to mature late. Some of the small depressions need shallow surface ditches to remove excess water.

Capability unit IIIe–1

This unit consists of moderately sloping soils on uplands and high stream benches. The soils are well drained or moderately well drained.

The surface layer is loam, silt loam, or silty clay loam. Permeability is moderate or moderately slow. Available water capacity is high. Organic matter content is low or moderate. Much organic matter has been lost by erosion. The surface layer is neutral to medium acid, depending on liming practices.

These soils are mostly cultivated and used intensively for row crops. They are moderately well suited to this use if erosion is controlled. Many areas of these soils are farmed with less sloping soils. Erosion control practices are important in those places.

In cultivated fields, the soils need to be tilled on the contour, stripcropped, or terraced to control erosion (fig. 14). Minimum tillage also is used to increase water intake and reduce the chances of erosion. Since many of these soils have lost as much as half or more of the original surface layer by erosion, additions of manure and good use of crop residue are needed.

Erosion control practices adapt well to the contour of the landscape on most of these soils, but in the northwestern part of the county these soils tend to have short, irregular slopes. Practices such as contour

Figure 14.—**Stripcropping on the contour to help control erosion. This soil is Tama silty clay loam, 5 to 9 percent slopes, moderately eroded, in capability unit IIIe–1.**

tillage are not easy to use. One practical alternative in many places is to farm the soils with adjoining strongly sloping or moderately steep soils and use them less for row cropping. Minimum tillage can be used along with the reduced use of row crops and other conservation practices that can be applied.

Capability unit IIIe–2

This unit consists of moderately sloping, well drained or moderately well drained soils on foot slopes and alluvial fans.

The surface layer is loam, silt loam, or silty clay loam. Permeability is moderate, and available water capacity is high. Organic matter content is high except in one soil, where it is low. Typically these soils have a slightly acid or medium acid surface layer unless limed.

Most areas of these soils are used for cultivated crops, but some of the less accessible areas are in pasture or are wooded. The soils are moderately well suited to row crops if erosion is controlled. Excess runoff from adjoining soils of the uplands flows over these soils, causing sheet erosion, rilling and gullying, siltation, and wetness.

Diversion terraces and conservation practices on the hillsides help to keep the runoff water off these soils. Grassed waterways help to prevent the formation and growth of gullies. Contour tillage and other conservation practices reduce rilling.

Capability unit IIIe–3

This unit consists of strongly sloping, moderately well drained and well drained soils on uplands.

The surface layer is loam, silt loam, or silty clay loam. Permeability is moderate or moderately slow. Available water capacity is high. Organic matter content is low or moderate. These soils generally have lost half or more of the original organic matter content by erosion. The surface layer ranges from strongly acid to neutral in others, depending on liming practices.

These soils are used mostly for cultivated crops. They are moderately well suited to row crops if erosion is controlled. Some of the soils that are associated with moderately steep or steep soils are left in pasture or trees.

Terraces can be used to control erosion. They are less well adapted to these soils than to less sloping soils, and they are difficult to build. They need to be spaced fairly close together. Commonly there are numerous drainageways on the hillside in this unit,

and they complicate the installation of terraces. Contour tillage stripcropping, and minimum tillage that leaves a good cover of mulch also help to control erosion.

Capability unit IIIe–4

This unit consists of gently sloping and moderately sloping, well drained to somewhat excessively drained soils on stream benches and uplands.

The surface layer is fine sandy loam. Permeability is moderately rapid to rapid. Available water capacity is moderate. Organic matter content is moderate. Typically the surface layer is medium acid unless limed.

These soils are mainly used for cultivated crops. They are moderately well suited to row crops. Erosion, soil blowing, and droughtiness are hazards. Rodent activity is a problem in places, especially where the soil is left in meadow for several years.

This soil is difficult to terrace because of the high content of sand and the topography. Contour tillage, stripcropping, and tillage methods that leave mulch on the surface are alternatives to terracing. Good use of crop residue and manure helps to control erosion and soil blowing and helps to conserve moisture.

Capability unit IIIw–1

This unit consists of nearly level soils on bottom lands. These soils are moderately well drained to very poorly drained. The surface layer ranges from silt loam to silty clay. In this unit there are also soils that are too variable to be mapped as a soil series. In some areas sandy soils are somewhat excessively drained. Properties vary considerably from place to place.

Permeability ranges from moderate to very slow. Available water capacity is high or moderate. Organic matter content is low to high. The surface layer generally is neutral or slightly acid. The permeability in some sandy soils is moderately rapid, and the available water capacity is low.

Some areas of these soils are used for cultivated crops. Other areas are in pasture or are wooded. These soils are moderately well suited to row crops if drainage is adequate and flooding is controlled. The hazard of flooding is severe. Wetness also is a hazard. Many areas have old channels and swales that pond water for long periods. Soils that have moderately fine texture or fine texture in the surface layer have a narrow range of moisture content in which the soils can be worked, so maintaining good tilth is difficult.

Levees or other flood control measures are needed if these soils are used for cultivated crops. Landsmoothing can eliminate swales and depressions. Artificial drainage is important, especially on the very poorly drained soils. Tile does not function well in the very poorly drained soils. Adequate outlets are unavailable in many areas. Drainage ditches are commonly used. Artificial drainage helps make field operations timely. However, maintaining good tilth on the clayey soils is difficult, even if drainage is adequate. Plowing is often in fall. Freezing and thawing improves the workability of the soils, but the fall-plowed soils are susceptible to soil blowing.

Capability unit IIIw–2

This unit consists of nearly level, poorly drained and very poorly drained soils in depressional areas on the uplands, low stream benches, or bottom lands.

The surface layer is silt loam. Permeability is slow or very slow. Available water capacity is high. Organic matter content is moderate or high. The surface layer typically is neutral, depending on liming practices.

Individual areas of these soils are small and are surrounded by nearly level soils that are well suited to row crops. These soils are farmed with the surrounding soils and are used intensively for row crops. They are only moderately well suited to row crops. Wetness is a hazard. Runoff from adjoining soils collects on these soils, causing them to pond for as long as a week or more, especially during the spring.

Because they are wet, these soils must be avoided when fieldwork is done. Crops drown out in some years. Deep cuts in the adjoining soils are needed to get suitable outlets for artificial drainage. The clayey subsoil reduces the effectiveness of tile drains, but they are used in places. Ditches are also used. Drainage is important to eliminate the small wet areas that hinder farm operations on the adjoining soils.

Capability unit IVe–1

This unit consists of strongly sloping and moderately steep soils on uplands. The soils are moderately well drained or well drained.

The surface layer is loam or silt loam except in one soil, where it is silty clay loam. Permeability is moderate or moderately slow. Available water capacity is high. Organic matter content is low or moderate. Most soils have lost about half of the original organic matter by erosion. The surface layer is neutral to strongly acid, depending on liming practices.

These soils are used for cultivated crops, hay, and pasture. A few areas are wooded. The soils are not well suited to cultivated crops, but row crops can be grown occasionally if erosion is controlled. Sheet erosion and, in places, gully erosion are hazards.

Terraces are hard to build on most areas of these soils because of their slopes. Contour tillage, stripcropping, and tillage methods that leave a mulch on the surface are alternatives to terraces (fig. 15). Farm machinery can be used on these soils. Fertilization, reseeding, and other practices help to produce good quality hay and pasture.

Capability unit IVe–2

This unit consists of strongly sloping soils on uplands or on remnants of high stream benches. They are poorly drained, somewhat poorly drained, moderately well drained, or well drained.

The surface layer is loam, clay loam, or silty clay loam. Permeability is moderate to very slow. Available water capacity is moderate or high. Organic matter content ranges from low or very low to high, depending on the amount of erosion that has occurred. Typically, the surface layer is medium acid, slightly acid, or neutral, depending on liming practices.

These soils are used for cultivated crops, hay, and pasture. They are not well suited to row crops, but

Figure 15.—**Stripcropping on side slopes to help control erosion and reduce runoff. The soil is Gara loam, 9 to 14 percent slopes, moderately eroded, in capability unit IVe–1.**

they can be planted occasionally if the hazards of wetness and erosion are controlled. Maintaining good tilth is a concern. These soils have a subsoil that is unfavorable for plant growth. Most are too clayey. Erosion is a serious hazard because it brings unfavorable material closer to the surface.

Terraces are not well suited to these soils because of the unfavorable subsoil and the slopes. Contour tillage, stripcropping, and tillage methods that leave mulch on the surface are alternatives to terraces. Wetness is caused by lateral movement of water downslope along the top of the clayey subsoil. Interceptor tile can be placed upslope to reduce this problem. Timely field operations are important to help to maintain good tilth.

These soils generally are associated with moderately steep or steep soils. They are commonly left in permanent pasture with those soils.

Capability unit IVe–3

This unit consists of strongly sloping, moderately well drained and well drained soils on uplands.

The surface layer is silt loam or silty clay loam. Permeability is moderate or moderately slow. Available water capacity is high. Organic matter content is low. The surface layer ranges from strongly acid to neutral, depending on liming practices.

The soils in this unit are mainly used for cultivated crops. Some areas have been changed to hayland or pasture. The soils are not well suited to cultivated crops but can be planted to row crops occasionally if erosion is controlled. Because much of the original surface layer and its organic matter has been lost by erosion, maintaining good tilth is a concern.

Terraces can be used on these soils, but they are not well suited. Slopes are steeper than desirable, and the low organic matter content restricts plant growth, especially in terrace channels. Contour tillage, stripcropping, and tillage methods that leave mulch on the surface are alternatives to terraces. Good use of crop residue and manure helps to improve tilth.

In many places these soils are associated with moderately steep or steep soils. Some areas are managed with those soils and are left in hay or pasture.

Capability unit IVe–4

Dickinson fine sandy loam, 9 to 14 percent slopes, is the only soil in this capability unit. This soil is strongly sloping and is well drained to somewhat excessively drained. It is on stream benches and uplands.

The surface layer is fine sandy loam. Permeability is moderately rapid. Available water capacity is moderate. Organic matter content is moderate. Typically, the surface layer is medium acid unless limed.

This soil is used for cultivated crops, hay, and pasture. It is not well suited to cultivated crops, but row crops can be grown occasionally if erosion is controlled. Water erosion, soil blowing, and droughtiness are hazards. Rodent activity is a concern in places, especially where the soil is left in meadow for several years.

This soil is difficult to terrace because of the high content of sand and the topography. Contour tillage, stripcropping, and tillage methods that leave mulch on the surface are alternatives to terracing. Good use of crop residue and manure helps to control erosion and soil blowing and conserve moisture.

Capability unit IVs–1

This unit consists of nearly level to moderately sloping, excessively drained soils on uplands and stream benches.

The surface layer is loamy fine sand. Permeability is rapid. Available water capacity is low. Organic matter content is low or very low. The surface layer is slightly acid or medium acid unless limed.

These soils are used for cultivated crops, hay, or pasture. A few areas are wooded. The soils are not well suited to cultivated crops, but row crops can be grown occasionally. Droughtiness, erosion, and soil blowing are hazards. Blowing sand is likely to damage newly seeded crops on these and adjacent soils.

Good use of crop residue and manure help to reduce erosion and soil blowing and conserve moisture. Farming operations should be on the contour on the sloping soils. Stripcropping is used in places. Terraces normally are not used because of the high content of sand in these soils. Selection of crops and grasses that are well adapted to these soils is important.

Capability unit IVw–1

Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded, is the only soil in this capability unit. This soil is moderately sloping and is poorly drained. It is on uplands.

The surface layer is silty clay loam. Permeability is very slow. Available water capacity is high. Typically, the organic matter content is moderate, depending on the amount of erosion that has occurred. The surface layer is slightly acid or neutral.

This soil is used for cultivated crops, hay, and pasture. It is not well suited to cultivated crops, but row crops can be grown occasionally if the wetness and erosion are controlled. Erosion is an especially serious concern, because it brings the clayey subsoil closer to the surface. Maintaining good tilth is difficult because this soil is wet.

Wetness is caused mainly by the lateral flow of water downslope along the top of the clayey subsoil. Interceptor tile can be placed upslope to reduce the flow. Terraces are not well suited because of the clayey subsoil. This soil normally is in narrow bands, however, so it is possible in many places to space terraces and leave the bands of this soil between the terraces. Timely field operations are important in maintaining good tilth, especially if drainage is not adequate. Water tolerant grasses and legumes are suited to this soil.

Capability unit Vw–1

This unit consists of nearly level and gently sloping, somewhat poorly drained and poorly drained soils on bottom lands and foot slopes. The unit also includes soils that are too mixed to be mapped as soil series. Soil properties vary widely from place to place in those areas.

The surface layer is dominantly silty clay loam and silt loam, but sandy loam and loam are also common. Permeability is moderate or moderately slow. Available water capacity is high. Organic matter content is moderate or high. Typically, the surface layer is slightly acid or neutral. Some sandy soils in this unit have low available water capacity and organic matter content.

Most of this unit is in trees or is wooded. In most places it is not suited to cultivated crops because of the severe limitations. Flooding is common to very frequent, and most areas are dissected by old channels or swales.

Use of these soils for cultivated crops generally requires levees or other flood control methods. Land smoothing and filling of gullies or channels are also important. These soils are suited to row crops if the limitations are overcome. Artificial drainage is beneficial on some of the soils. Tile systems are suitable if outlets are available. Some of the sandy soils tend to be droughty. Management is limited by the flooding where these soils are left in pasture or trees. Some of the areas are not readily accessible to farm equipment.

Capability unit VIe–1

This unit consists of moderately steep and steep, moderately well drained, well drained, and somewhat excessively drained soils on uplands.

The surface layer is loam or silt loam. The permeability is moderate or moderately slow. The available water capacity is high. The organic matter content ranges from very low to moderate. Surface reaction is neutral or slightly acid.

These soils generally are wooded or are in pasture. They are well suited to hay, pasture, or woodland. They also provide excellent habitat for wildlife. These soils have a number of suitable sites for ponds that provide water for livestock. Erosion is a hazard. Control of grazing is needed to prevent serious damage to vegetation. Wooded areas also need to be protected from grazing. Diversion terraces near the base of these soils help protect soils downslope from runoff.

Capability unit VIe–2

This unit consists mainly of moderately steep, moderately well drained, well drained, and somewhat poorly drained soils on uplands. One soil is strongly sloping.

The surface layer is silt loam, loam, or clay loam. Permeability is moderately slow, slow, or very slow. In most of the soils, the available water capacity is high. In a few of the soils it is low to moderate. Organic matter content ranges from low to moderate. Typically, surface reaction is neutral or slightly acid.

Most of these soils are in pasture (fig. 16) or are wooded, and they are well suited to these uses. Farm machinery can be used on most areas of these soils. Hay can also be grown. Erosion is a serious hazard. Wetness is a hazard on many of the soils. Gullies are common.

An occasional crop of corn as the first step in renovating hayland or pasture is suitable on these soils if erosion is controlled. Contour tillage, stripcropping, and practices that leave a mulch on the surface can be used to control erosion. Terraces are not well suited because of the steep slopes and clayey subsoil of many of these soils. Wetness is caused by the lateral movement of water downslope along the top of the clayey subsoil. If farm machinery is to be used frequently, interceptor tile upslope will help to dry these soils and make timely operations easier.

Where these soils are used for pasture or trees, control of grazing is important in maintaining good stands.

Capability unit VIs–1

This unit consists of strongly sloping and moderately steep soils on the uplands. These soils are excessively drained.

The surface layer is loamy fine sand. Permeability is rapid or very rapid. Available water capacity is low. Organic matter content is low or very low. Surface reaction is slightly acid or medium acid.

The soils of this unit are mainly used for pasture. A few areas are wooded. These soils are suited to hay, pasture, or woodland. They are droughty and are susceptible to erosion and soil blowing. Farm machinery can be used to establish hay or to renovate pastures. It is important to keep a good cover on these soils to help to conserve moisture and to control erosion and soil blowing. Controlling grazing is essential.

Figure 16.—An area of Lindley loam, 14 to 18 percent slopes; in foreground in pasture. This soil is in capability unit VIe–2.

Capability unit VIIe–1

This unit consists of moderately steep, steep, and very steep soils on the uplands. These soils are moderately well drained, well drained, and somewhat poorly drained.

The surface layer is silt loam, loam, and clay loam. Permeability ranges from moderate to very slow. Available water capacity is high in most of the soils, but it is low in one of the soils. Organic matter content ranges from moderately low to very low. The surface layer typically is neutral or slightly acid.

These soils are used for pasture and trees. A few areas are used for recreation and wildlife habitat.

Erosion is a hazard. Gullies are common. One of these soils tends to be wet because of lateral flow of water downslope along the top of the clayey subsoil.

Grazing needs to be controlled to assure permanent cover of vegetation. Some areas can be planted to trees. In other areas, however, it is difficult to establish trees because of steep slope. Renovated areas need to be fenced to protect them from overgrazing.

Capability unit VIIs–1

This unit consists of moderately steep, steep, and very steep, well drained and excessively drained soils on the uplands.

The surface layer is silt loam or loamy fine sand. Permeability of the sandy soils is rapid and of the silty soils is moderate. Available water capacity is low in the sandy soils and high in the silty soils. Organic matter content is very low or low. Typically, the surface layer is medium acid or slightly acid.

Most areas are in permanent pasture or trees, to which the soils are well suited. Erosion and droughtiness are hazards.

Controlling grazing is important on these soils. In some areas machinery can be used to renovate pasture or to plant trees, but many areas are too steep. These soils are suitable for recreation and for wildlife habitat.

Capability unit VIIw–1

Marsh is the only mapping unit in this capability unit. It consists of very wet areas and areas that are under water most of the year.

Marsh has little or no value for farming. Areas are mainly in low places and lack suitable outlets for drainage. Some areas could be reclaimed for pasture or cultivated crops if the water level could be controlled.

Marsh is well suited to wildlife habitat. Plants that tolerate wetness grow well in the marshy areas. Waterfowl, fur-bearing animals, and other wildlife find cover, food, and nesting places in and around the areas.

Environmental plantings

In table 3 the three environmental planting groups in Jasper County are defined and the trees and shrubs suitable for each group are listed.

Some suggested tree and shrub species are given for each group for the following uses: shade trees, street trees, hedges and screens, woodland plantings, windbreak plantings, and wildlife plantings. The lists are not intended to be complete, and the plants are not listed in any particular order. Individual taste and the advice of specialists will determine which species will be used.

Wildlife habitat[3]

Wildlife is a product of the soil. There is a direct relationship between soil fertility and the kinds and numbers of wildlife in a given area. Other characteristics of the soil such as slope, permeability, and drainage also affect wildlife habitat. All of these factors are important in developing shallow water areas for waterfowl and constructing ponds for fish. All qualities of the soil help to determine the potential of land for developing the various types of wildlife habitat.

In Jasper County many factors affect development of wildlife habitat and the resulting wildlife populations. In intensively farmed areas personal preferences mainly determine the types of crops planted and other uses of the land. The resulting type of vegetation (habitat) or lack of it determines the kinds of wildlife that will inhabit the area.

Wildlife generally requires three things from the habitat for survival: (1) food, (2) cover for protection from enemies and weather, and (3) a suitable site to produce young. Fortunately, most farm crops provide food, cover, or a place to produce young for some type of wildlife. Sometimes proper habitat is not enough. Other factors such as disease, extreme weather conditions, predation, and hunting pressure affect wildlife populations; therefore, good wildlife habitat is not a guarantee of abundant wildlife populations.

Table 4 shows the potential of each soil in Jasper County to produce seven habitat elements: grain and seed crops, grasses and legumes, wild herbaceous plants, hardwood trees and shrubs, coniferous trees and shrubs, wetland plants, and shallow water areas.

Grain and seed crops include corn, oats, soybeans, barley, and rye. These plants provide food for many kinds of wildlife.

Grasses and legumes include bromegrass, switchgrass, indiangrass, big bluestem, alfalfa, red clover, and wild sweetclover. Such vegetation is important for nesting birds, especially pheasants, and provides cover for small mammals.

Wild herbaceous plants provide both food and cover for many forms of wildlife. Examples of these plants include goldenrod, sunflower, pigweed, dock, and ragweed.

Hardwood trees and shrubs lose their leaves each winter. Examples include oak, maple, elm, basswood, walnut, hickory, honeysuckle, dogwood, and ninebark. Their leaves, buds, or seeds provide important food for squirrels, deer, and birds.

Coniferous trees and shrubs retain their leaves throughout the year. These include eastern white pine, eastern red cedar, Austrian pine, Norway spruce, Scotch pine, jack pine, and Pfitzer juniper. These plants furnish important winter cover for birds and mammals.

Wetland plants include smartweed, bulrush, cattail, and arrowhead. These plants provide both food and cover for the many kinds of waterfowl and fur-bearing mammals.

[3] BILL D. WELKER, biologist, Soil Conservation Service, assisted with the preparation of this section.

TABLE 3.—*Environmental planting groups of*

Environmental planting group	Shade trees	Street trees
Group 1: Well drained to somewhat poorly drained soils; mostly high or moderate available water capacity and moderately fine textured or medium textured surface layer.	American basswood, honey locust, green ash, hackberry, sugar maple, silver maple.	Green ash, hackberry, pin oak, sugar maple.
Group 2: Poorly drained and very poorly drained soils; mostly high available water capacity and medium textured or moderately fine textured surface layer.	Silver maple, hackberry, sycamore, green ash.	Hackberry, sycamore, green ash.
Group 3: Excessively drained soils; low available water capacity and coarse textured surface layer.	Scarlet oak, bur oak, hackberry, green ash, silver maple.	Hackberry, green ash [1]

[1] Not well suited to very poorly drained soils.

Shallow water areas refers to the capacity of a soil to hold water for water areas with a maximum depth of five feet.

The soils in table 4 are rated on the basis of *good, fair, poor,* or *very poor*. Generally, soils producing the most abundant crop of grain, grass, or legume or providing the best conditions for growing conifers, hardwoods, wild herbaceous plants, wetland plants or for holding water for impoundment would also be rated *good.*

Artificially drained soils can produce different vegetation than soils that are naturally poorly drained. Artificially drained soils in Jasper County are used to produce grain and seed crops or grasses and legumes. Therefore, poorly drained soils in table 4 rated for these two habitat elements are given a dual rating for drained and undrained conditions, respectively.

In table 4, various combinations of habitat elements are evaluated for their potential to develop habitat for three general types of wildlife: Open-land, woodland, and wetland.

Open-land wildlife include the birds and mammals of croplands, pastures, meadows, road ditches, railroad rights-of-way, and unused areas overgrown with grasses, forbs, and shrubs. Open-land wildlife in Jasper County include bobwhite, quail, pheasant, meadowlark, cottontail rabbit, red fox, coyote, badger, and woodchuck. Much of the open-land wildlife habitat is in the Tama-Killduff-Muscatine, Otley-Mahaska, and Downs-Tama-Shelby associations.

Woodland wildlife inhabit areas containing hardwood trees, shrubs, or coniferous trees. These areas are mainly in the Ladoga-Gara and Sparta-Chelsea-Dickinson associations in Jasper County. Examples of this wildlife are fox squirrels, raccoon, woodpecker, and white-tailed deer.

Wetland wildlife mostly occupy the many ponds and streams; few natural wetland areas remain in Jasper County. Examples of wetland wildlife are the many species of waterfowl, shore birds, mink, muskrat, and beaver.

There is a great diversity of fish and wildlife in Jasper County and proper planning can improve the quality of this wildlife by providing or improving habitat. Planning assistance can be obtained from local representatives of the Iowa Conservation Commission and the Jasper County Soil Conservation District.

Recreational development

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 5 the soils of Jasper County are rated according to limitations that affect their suitability for camp areas, playgrounds, picnic areas, and paths and trails.

In table 5 the soils are rated as having slight, moderate, or severe limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means that soil properties are generally favorable and limitations are so minor that they easily can be overcome. A *moderate* limitation can be overcome or modified by planning, by design, or by special maintenance. A *severe* limitation means that costly soil reclamation, special design, intense maintenance, or a combination of these, is required.

Camp areas are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes, good drainage, and a surface free of rocks and coarse fragments; they are not subject to flooding during periods of heavy use; and their surface is firm after rain but not dusty when dry.

Picnic areas are attractive natural or landscaped tracts that carry heavy foot traffic. Most of the ve-

soils and suited trees and shrubs for plantings

Hedges and screens	Woodland plantings	Windbreak plantings	Wildlife plantings
Lilac, American cranberrybush, Tatarian honeysuckle, silky dogwood, arrowwood viburnum, hawthorn.	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple, selected poplars.	Eastern white pine, red pine, Colorado blue spruce, Norway spruce, Scotch pine, white spruce, European larch, eastern redcedar, green ash, hackberry, eastern cottonwood, Douglas fir, Tatarian honeysuckle, pin oak, Russian-olive, silver maple, lilac.	Blackhaw, lilac, gray dogwood, alternate-leaf dogwood, autumn-olive, Tatarian honeysuckle, midwest Manchurian crabapple.
Northern whitecedar, silky dogwood, American cranberrybush, Lombardy poplar.	Eastern cottonwood	Silver maple, selected poplars, laurel willow, sycamore, green ash, hackberry,[1] northern whitecedar,[1] eastern redcedar,[1] white spruce,[1] Norway spruce.[1]	Red-osier dogwood, eastern redcedar, northern whitecedar, silky dogwood, American cranberrybush.
Eastern redcedar, Russian-olive, honeysuckle, lilac, Siberian peashrub.	Eastern white pine, Scotch pine, European larch, eastern redcedar.	Red pine, eastern white pine, Scotch pine, eastern redcedar, green ash, hackberry, Siberian peashrub.	Blackhaw, lilac, gray dogwood, alternate-leaf dogwood, autumn-olive.

TABLE 4.—*Potential of the*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops [1]	Grasses and legumes [1]	Wild herbaceous plants	Hardwood trees and shrubs
Ackmore:				
430	Good	Good	Good	Good
5B	Good	Good	Good	Good
C5B	Very poor	Poor	Fair	Fair
Adair: 192D2	Fair	Good	Good	Good
Alluvial land, channeled: C315	Very poor	Fair	Fair	Fair
Alluvial land-Nodaway complex: 315	Fair	Fair	Fair	Good
Armstrong: 792D2	Fair	Good	Good	Good
Atterberry: 291	Good	Good	Good	Good
Bauer:				
185E2	Poor	Fair	Good	Fair
185F2	Very poor	Fair	Fair	Poor
Bolan: 174	Fair	Good	Good	Good
Bremer: 43	Good to fair	Good to fair	Good	Fair
Caleb:				
94D2	Fair	Good	Good	Good
94E2	Poor	Fair	Good	Good
Canisteo: 507	Good to fair	Good to fair	Fair	Fair
Chelsea:				
63C, 63D	Poor	Poor	Fair	Poor
63E	Very poor	Very poor	Fair	Poor
293G	Very poor	Very poor	Fair	Poor
Clarinda: 222C2, 222D2	Fair to poor	Fair to poor	Fair	Fair
Clarion:				
138B	Good	Good	Good	Good
138C2	Fair	Good	Good	Good
138D2	Fair	Good	Good	Good
138E2	Fair	Fair	Good	Good
Clinton: 80C2, 80D2, 80D3, 80E2	Fair	Good	Good	Good
Coland: 135, 135B	Good to fair	Good to fair	Fair	Fair
Colo: 133+, 133	Good to fair	Good to fair	Good	Fair
Dickinson: 175B, 175C, 175D	Fair	Fair	Fair	Fair
Downs:				
162, 162B, T162B	Good	Good	Good	Good
162C2, T162C, 162D2, 162E2	Fair	Good	Good	Good
Ely: 428B	Good	Good	Good	Fair
Fayette:				
163B	Good	Good	Good	Good
163C2, 163D2, 163E2, 163D3	Fair	Good	Good	Good
163F2	Poor	Fair	Good	Good
Flagler: 284B	Fair	Good	Good	Fair
Gara:				
179D2	Fair	Good	Good	Good
179E2	Poor	Fair	Good	Good
179F2, 179G	Very poor	Very poor	Good	Good
993D2	Fair	Good	Good	Good
993E2, 993E3	Very poor	Very poor	Good	Good

soils for wildlife habitat

Elements of wildlife habitat—Cont.			Kinds of wildlife habitat		
Coniferous trees and shrubs	Wetland plants	Shallow water areas	Open-land [1]	Woodland	Wetland
Fair	Good	Good	Good	Good	Good.
Fair	Good	Good	Good	Good	Good.
Poor	Good	Good	Poor	Fair	Good.
Good	Very poor	Very poor	Good	Good	Very poor.
Poor	Good	Fair	Fair	Good	Fair.
Fair	Good	Fair	Fair	Good	Fair.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Fair	Poor	Good	Good	Very poor.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Good to fair	Fair	Good.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Poor	Good	Fair	Good to fair	Fair	Fair.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Poor	Very poor	Very poor	Poor	Poor	Very poor.
Poor	Very poor	Very poor	Fair to poor	Fair	Very poor.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Good to fair	Fair	Good.
Poor	Good	Good	Good to fair	Fair	Good.
Fair	Very poor	Very poor	Fair	Fair	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Poor	Poor	Very poor	Good	Fair	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Fair	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Very poor	Very poor	Poor	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.

TABLE 4.—*Potential of the soils*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops [1]	Grasses and legumes [1]	Wild herbaceous plants	Hardwood trees and shrubs
Garwin:				
118	Good to fair	Good to fair	Good	Fair
117	Good to fair	Good to fair	Good	Fair
Hayden:				
168E2, 168F	Poor	Fair	Good	Good
168G	Very poor	Poor	Good	Good
Judson: 8, 8B, 8C	Good	Good	Good	Good
Kennebec: 212	Good	Good	Good	Good
Killduff:				
20C2, 20D2	Fair	Good	Good	Good
20E2	Poor	Good	Good	Good
Ladoga:				
76B	Good	Good	Good	Good
76C2, 76D2	Fair	Good	Good	Good
Lamoni:				
822D2	Fair	Good	Good	Good
822E2	Poor	Fair	Good	Good
Lawler: 226, 225	Fair	Good	Good	Good
Lester:				
236B	Good	Good	Good	Good
236C2, 236D2	Fair	Good	Good	Good
Lindley:				
65E	Poor	Fair	Good	Good
65E3, 65F, 65G	Very poor	Poor	Good	Good
Mahaska: 280	Good	Good	Good	Good
Marsh: 354	Poor to very poor	Poor to very poor	Poor to very poor	Poor to very poor
Martinsburg:				
742B	Good	Good	Good	Good
742C	Fair	Good	Good	Good
Muscatine: 119	Good	Good	Good	Good
Mystic: Mapped in complex with Caleb soils.				
Nevin: 88	Good	Good	Good	Good
Nicollet: 55	Good	Good	Good	Good
Nira:				
570B2	Good	Good	Good	Good
570C2, 570D2	Fair	Good	Good	Good
Nodaway: 220	Good	Good	Good	Good
Olmitz:				
273B	Good	Good	Good	Good
273C	Fair	Good	Good	Good
Otley:				
281B	Good	Good	Good	Good
281C2	Fair	Good	Good	Good
281D2	Fair	Good	Good	Good
Port Byron:				
620C2, 620D2, 620E2	Fair	Good	Good	Good
620F2	Poor	Fair	Fair	Good

for wildlife habitat—Continued

Elements of wildlife habitat—Cont.			Kinds of wildlife habitat		
Coniferous trees and shrubs	Wetland plants	Shallow water areas	Open-land [1]	Woodland	Wetland
Poor	Good	Fair	Good to fair	Fair	Fair.
Poor	Good	Good	Good to fair	Fair	Good.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Very poor	Very poor	Poor	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Good	Fair	Good	Good	Fair.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Fair	Very poor.
Fair	Fair	Very poor	Good	Good	Poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Very poor	Very poor	Poor	Good	Very poor.
Fair	Fair	Fair	Good	Good	Fair.
Poor to very poor	Good	Good	Poor to very poor	Very poor	Good.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Poor	Good	Good	Poor.
Fair	Fair	Fair	Good	Good	Fair.
Good	Fair	Fair	Good	Good	Fair.
Fair	Fair	Fair	Good	Good	Fair.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Fair	Fair	Good	Good	Fair.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.

TABLE 4.—*Potential of the soils*

Soil series and map symbols	Elements of wildlife habitat			
	Grain and seed crops [1]	Grasses and legumes [1]	Wild herbaceous plants	Hardwood trees and shrubs
Shelby:				
24D2, 24E2	Fair	Good	Good	Good
24F2	Poor	Fair	Good	Good
93D2	Fair	Good	Good	Good
93E2	Poor	Fair	Good	Good
Sparta: 41B, 41C2, 41D2	Poor	Poor	Fair	Poor
Sperry: 122	Fair to poor	Fair to poor	Fair	Fair
Storden:				
62D, 62E	Fair	Good	Fair	Fair
62F	Poor	Fair	Fair	Fair
Taintor: 279	Good to fair	Good to fair	Good	Fair
Tama:				
120	Good	Good	Good	Good
120B, T120B	Good	Good	Good	Good
120C2, T120C, 120D2	Fair	Good	Good	Good
Terril: 27B	Good	Good	Good	Good
Tuskeego: 453	Fair to poor	Fair to poor	Fair	Fair
Wabash: 172	Fair to poor	Fair to poor	Poor	Very poor
Webster: 107	Fair to poor	Good to poor	Good	Fair
Wiota: 7	Good	Good	Good	Good
Zook: 54	Good to fair	Good to fair	Good	Fair

[1] Dual ratings are for drained and undrained conditions.

hicular traffic, however, is confined to access roads. The best soils are firm when wet but not dusty when dry, are not subject to flooding during the season of use, and do not have slopes or stones that can greatly increase the cost of leveling or of building access roads.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use need to withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops. They have good drainage and are not subject to flooding during periods of heavy use. Their surface is firm after rain but not dusty when dry. If grading and leveling are required, depth to rock is important.

Paths and trails are used for local and cross-country travel by foot or horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded not more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

Information in table 5 can be supplemented by additional information in other parts of this survey. For example, especially helpful in evaluating sites for recreational development are interpretations for septic tank absorption fields and for local roads and streets in table 7.

Engineering uses of the soils [4]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and reaction. Also important are depth to the water table, depth to bedrock, and slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds, and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.

[4] VOLNEY SMITH, engineer, Soil Conservation Service, assisted in preparation of this section.

for wildlife habitat—Continued

Elements of wildlife habitat—Cont.			Kinds of wildlife habitat		
Coniferous trees and shrubs	Wetland plants	Shallow water areas	Open-land [1]	Woodland	Wetland
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Fair	Good	Very poor.
Fair	Very poor	Very poor	Poor	Fair	Very poor.
Poor	Good	Good	Fair to poor	Fair	Good.
Poor	Very poor	Very poor	Fair	Fair	Very poor.
Poor	Very poor	Very poor	Fair	Fair	Very poor.
Poor	Good	Fair	Good to fair	Fair	Fair.
Good	Poor	Poor	Good	Good	Poor.
Good	Poor	Very poor	Good	Good	Very poor.
Good	Very poor	Very poor	Good	Good	Very poor.
Good	Poor	Very poor	Good	Good	Very poor.
Poor	Good	Good	Fair to poor	Fair	Good.
Very poor	Good	Good	Fair to poor	Very poor	Good.
Poor	Good	Good	Good to fair	Fair	Good.
Good	Poor	Poor	Good	Good	Poor.
Poor	Good	Good	Good to fair	Fair	Good.

4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 6 and 7, which show, respectively, several estimated soil properties significant to engineering and interpretations for various engineering uses.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 6 and 7, and it also can be used to make other useful maps.

This information, however, does not eliminate need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have different meanings in soil science than in engineering. The "Glossary" defines many of these terms as they are commonly used in soil science.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*2*), used by SCS engineers, the Department of Defense, and others, and the AASHTO system (*1*), adopted by the American Association of State Highway and Transportation Officials.

The Unified system is used to classify soils according to engineering uses for building material or for the support of structures other than highways. Soils are classified according to particle size distribution, plasticity index, liquid limit, and organic matter content. Soils are grouped into 15 classes. There are eight classes of coarse-grained soils that are subdivided on the basis of gravel and sand content; these are identified as GW, GP, GM, GC, SW, SP, SM, and SC. Six classes of fine-grained soils are subdivided on the basis of the plasticity index; nonplastic classes are ML, MH,

TABLE 5.—*Use of soils for recreational development*

Soil series and map symbols	Degree of limitation and major features affecting—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ackmore: 430	Severe: subject to flooding; somewhat poorly drained.	Severe: subject to flooding; somewhat poorly drained.	Severe: subject to flooding; somewhat poorly drained.	Moderate: somewhat poorly drained; subject to flooding.
5B, C5B	Severe: subject to flooding; somewhat poorly drained and poorly drained.	Severe: subject to flooding; somewhat poorly drained and poorly drained.	Severe: subject to flooding; somewhat poorly drained and poorly drained.	Severe: subject to flooding; poorly drained and somewhat poorly drained.
Adair: 192D2	Moderate: moderately well drained to somewhat poorly drained; slow permeability; slopes of 9 to 14 percent; clay loam surface layer.	Moderate: moderately well drained to somewhat poorly drained; slopes of 9 to 14 percent; clay loam surface layer.	Severe: moderately well drained to somewhat poorly drained; slow permeability; slopes of 9 to 14 percent; clay loam surface layer.	Moderate: moderately well drained to somewhat poorly drained; clay loam surface layer.
Alluvial land: 315, C315	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding.
Armstrong: 792D2	Moderate: moderately well drained to somewhat poorly drained; slow permeability; slopes of 9 to 14 percent.	Moderate: moderately well drained to somewhat poorly drained; slopes of 9 to 14 percent.	Severe: moderately well drained to somewhat poorly drained; slow permeability; slopes of 9 to 14 percent.	Moderate: moderately well drained to somewhat poorly drained.
Atterberry: 291	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.
Bauer: 185E2	Severe: very slow permeability; slopes of 9 to 18 percent.	Moderate: slopes of 9 to 18 percent.	Severe: very slow permeability; slopes of 9 to 18 percent.	Moderate: slopes of 9 to 18 percent.
185F2	Severe: very slow permeability; slopes of 18 to 40 percent.	Severe: slopes of 18 to 40 percent.	Severe: very slow permeability; slopes of 18 to 40 percent.	Severe: slopes of 18 to 40 percent.
Bolan: 174	Slight	Slight	Slight	Slight.
Bremer: 43	Severe: poorly drained; slow to moderately slow permeability; occasional flooding; silty clay loam surface layer.	Severe: poorly drained; occasional flooding; silty clay loam surface layer.	Severe: poorly drained; occasional flooding; slow to moderately slow permeability; silty clay loam surface layer.	Severe: poorly drained; occasional flooding; silty clay loam surface layer.
Caleb: 94D2	Moderate: moderately well drained to somewhat poorly drained; moderate to slow permeability; slopes of 9 to 14 percent.	Moderate: moderately well drained to somewhat poorly drained; slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent; moderately well drained to somewhat poorly drained.	Moderate: moderately well drained to somewhat poorly drained.
94E2	Severe: slopes of 14 to 18 percent; moderately drained to somewhat poorly drained.	Severe: slopes of 14 to 18 percent; moderately well drained to somewhat poorly drained.	Severe: slopes of 14 to 18 percent; moderately well drained to somewhat poorly drained.	Moderate: moderately well drained to somewhat poorly drained; slopes of 14 to 18 percent.
Canisteo: 507	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.
Chelsea: 63C	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Severe: slopes of 2 to 9 percent; loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.

TABLE 5.—*Use of soils for recreational development*—Continued

Soil series and map symbols	Degree of limitation and major features affecting—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
63D	Moderate: slopes of 9 to 14 percent; loamy fine sand surface layer.	Moderate: slopes of 9 to 14 percent; loamy fine sand surface layer.	Severe: slopes of 9 to 14 percent; loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.
63E	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Moderate: slopes of 14 to 25 percent.
293G	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.
Clarinda: 222C2, 222D2	Severe: poorly drained; very slow permeability; slopes of 5 to 14 percent.	Severe: poorly drained; slopes of 5 to 14 percent.	Severe: poorly drained; silty clay loam surface layer; slopes of 5 to 14 percent.	Severe: poorly drained; silty clay loam surface layer.
Clarion:				
138B	Slight: slopes of 2 to 5 percent.	Slight: slopes of 2 to 5 percent.	Moderate: slopes of 2 to 5 percent.	Slight.
138C2	Slight: slopes of 5 to 9 percent.	Moderate: slopes of 5 to 9 percent.	Severe: slopes of 5 to 9 percent.	Slight.
138D2	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
138E2	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent.	Moderate: slopes of 14 to 18 percent.
Clinton:				
80C2	Moderate: moderately slow permeability.	Slight: slopes of 5 to 9 percent.	Severe: slopes of 5 to 9 percent; moderately slow permeability.	Slight.
80D2, 80D3	Moderate: slopes of 9 to 14 percent; moderately slow permeability.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
80E2	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent.	Moderate: slopes of 14 to 18 percent.
Coland: 135, 135B	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.
Colo: 133, 133+	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.
Dickinson:				
175B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
175C	Slight	Slight	Severe: slopes of 5 to 9 percent.	Slight.
175D	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight: slopes of 9 to 14 percent.
Downs:				
162	Slight	Slight	Slight	Slight.
162B, T162B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
162C2, T162C, 162D2	Moderate: slopes of 5 to 14 percent.	Moderate: slopes of 5 to 14 percent.	Severe: slopes of 5 to 14 percent.	Slight.
162E2	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent.	Moderate: slopes of 14 to 18 percent.

TABLE 5.—*Use of soils for recreational development*—Continued

Soil series and map symbols	Degree of limitation and major features affecting—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ely: 428B	Moderate: somewhat poorly drained; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer; slopes of 2 to 5 percent.	Moderate: somewhat poorly drained; silty clay loam surface layer.
Fayette:				
163B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
163C2	Moderate: slopes of 5 to 9 percent.	Moderate: slopes of 5 to 9 percent.	Severe: slopes of 5 to 9 percent.	Slight.
163D2, 163D3	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
163E2, 163F2	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Moderate: slopes of 14 to 25 percent.
Flagler: 284	Slight	Slight	Slight	Slight.
Gara:				
179D2	Moderate: moderately slow permeability; slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
179E2, 179F2	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Moderate: slopes of 14 to 25 percent.
179G	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.
993D2	Moderate: well drained to somewhat poorly drained; moderately slow and slow permeability; slopes of 9 to 14 percent.	Moderate: well drained to somewhat poorly drained; slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent; well drained to somewhat poorly drained; moderately slow and slow permeability.	Moderate: well drained to somewhat poorly drained.
993E2, 993E3	Severe: slopes of 14 to 18 percent; well drained to somewhat poorly drained; moderately slow and slow permeability.	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent; well drained to somewhat poorly drained; moderately slow to slow permeability.	Moderate: well drained to somewhat poorly drained.
Garwin:				
118	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.
117	Severe: poorly drained and very poorly drained; moderately slow and very slow permeability.	Severe: poorly drained and very poorly drained.	Severe: poorly drained and very poorly drained; moderately slow and very slow permeability.	Severe: poorly drained and very poorly drained.
Hayden:				
168E2, 168F	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Moderate: slopes of 14 to 25 percent.
168G	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.
Judson:				
8	Slight	Slight	Slight	Slight.
8B	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: slopes of 2 to 5 percent; silty clay loam surface layer.	Moderate: silty clay loam surface layer.

TABLE 5.—*Use of soils for recreational development*—Continued

Soil series and map symbols	Degree of limitation and major features affecting—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
8C	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Severe: slopes of 5 to 9 percent.	Moderate: silty clay loam surface layer.
Kennebec: 212	Severe: subject to flooding.	Moderate: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding.
Killduff: 20C2, 20D2	Moderate: slopes of 5 to 14 percent; silty clay loam surface layer.	Moderate: slopes of 5 to 14 percent; silty clay loam surface layer.	Severe: slopes of 5 to 14 percent.	Moderate: silty clay loam surface layer.
20E2	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent.	Moderate: slopes of 14 to 18 percent.
Ladoga: 76B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
76C2	Slight	Slight	Severe: slopes of 5 to 9 percent.	Slight.
76D2	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
Lamoni: 822D2	Severe: somewhat poorly drained; slow to very slow permeability.	Moderate: somewhat poorly drained; slopes of 9 to 14 percent; silty clay loam surface layer.	Severe: somewhat poorly drained; slow to very slow permeability; slopes of 9 to 14 percent.	Moderate: somewhat poorly drained; silty clay loam surface layer.
822E2	Severe: somewhat poorly drained; slow to very slow permeability; slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent.	Severe: somewhat poorly drained; slow to very slow permeability; slopes of 14 to 18 percent.	Moderate: somewhat poorly drained; silty clay loam surface layer.
Lawler: 226, 225	Severe: somewhat poorly drained; occasional flooding.	Moderate: somewhat poorly drained; occasional flooding.	Moderate: somewhat poorly drained; occasional flooding.	Moderate: somewhat poorly drained; occasional flooding.
Lester: 236B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
236C2	Slight	Slight	Severe: slopes of 5 to 9 percent.	Slight.
236D2	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
Lindley: 65E, 65E3, 65F	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Moderate: slopes of 14 to 25 percent.
65G	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.	Severe: slopes of 25 to 40 percent.
Mahaska: 280	Moderate: somewhat poorly drained; moderately slow permeability; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.	Moderate: somewhat poorly drained; moderately slow permeability; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.
Marsh: 354	Severe: standing water much of time.	Severe: standing water much of time.	Severe: standing water much of time.	Severe: standing water much of time.
Martinsburg: 742B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
742C	Slight	Moderate: slopes of 5 to 9 percent.	Severe: slopes of 5 to 9 percent.	Slight.

TABLE 5.—*Use of soils for recreational development*—Continued

Soil series and map symbols	Degree of limitation and major features affecting—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Muscatine: 119	Moderate: somewhat poorly drained; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.
Mystic: Mapped with Caleb soils.				
Nevin: 88	Moderate: somewhat poorly drained; moderate to moderately slow permeability; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.	Moderate: somewhat poorly drained; moderate to moderately slow permeability; silty clay loam surface layer.	Moderate: somewhat poorly drained; silty clay loam surface layer.
Nicollet: 55	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.
Nira:				
570B2	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.
570C2, 570D2	Moderate: slopes of 5 to 14 percent; silty clay loam surface layer.	Moderate: slopes of 5 to 14 percent; silty clay loam surface layer.	Moderate: moderately slow permeability; slopes of 5 to 14 percent; silty clay loam surface layer.	Moderate: silty clay loam surface layer.
Nodaway: 220	Severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding.
Olmitz:				
273B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
273C	Slight	Slight	Severe: slopes of 5 to 9 percent.	Slight.
Otley:				
281B	Moderate: moderately slow permeability; silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: moderately slow permeability; slopes of 2 to 5 percent; silty clay loam surface layer.	Moderate: silty clay loam surface layer.
281C2, 281D2	Moderate: moderately slow permeability; slopes of 5 to 14 percent; silty clay loam surface layer.	Moderate: slopes of 5 to 14 percent; silty clay loam surface layer.	Severe: slopes of 5 to 14 percent.	Moderate: silty clay loam surface layer.
Port Byron:				
620C2	Slight	Slight	Severe: slopes of 5 to 9 percent.	Slight.
620D2	Moderate: slopes of 9 to 14 percent.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
620E2, 620F2	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Moderate: slopes of 14 to 18 percent.
Shelby:				
24D2	Moderate: slopes of 9 to 14 percent; moderately slow permeability.	Moderate: slopes of 9 to 14 percent.	Severe: slopes of 9 to 14 percent.	Slight.
24E2, 24F2	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Moderate: slopes of 14 to 25 percent.

TABLE 5.—*Use of soils for recreational development*—Continued

Soil series and map symbols	Degree of limitation and major features affecting—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
93D2	Moderate: moderately well drained to somewhat poorly drained; slow permeability; slopes of 9 to 14 percent; clay loam surface layer.	Moderate: moderately well drained to somewhat poorly drained; slopes of 9 to 14 percent; clay loam surface layer.	Severe: slopes of 9 to 14 percent.	Moderate: moderately well drained to somewhat poorly drained; clay loam surface layer.
93E2	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent.	Severe: slopes of 14 to 18 percent.	Moderate: moderately well drained to somewhat poorly drained; clay loam surface layer.
Sparta:				
41B	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer; slopes of 1 to 5 percent.	Moderate: loamy fine sand surface layer.
41C2	Moderate: loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.	Severe: slopes of 5 to 9 percent.	Moderate: loamy fine sand surface layer.
41D2	Moderate: slopes of 9 to 18 percent; loamy fine sand surface layer.	Moderate: slopes of 9 to 18 percent; loamy fine sand surface layer.	Severe: slopes of 9 to 18 percent; loamy fine sand surface layer.	Moderate: loamy fine sand surface layer.
Sperry: 122	Severe: very poorly drained to poorly drained; slow to very slow permeability.	Severe: very poorly drained to poorly drained.	Severe: very poorly drained to poorly drained; slow to very slow permeability.	Severe: very poorly drained to poorly drained.
Storden:				
62D	Moderate: slopes of 5 to 14 percent.	Moderate: slopes of 5 to 14 percent.	Severe: slopes of 5 to 14 percent.	Slight.
62E, 62F	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Severe: slopes of 14 to 25 percent.	Moderate: slopes of 14 to 25 percent.
Taintor: 279	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.
Tama:				
120	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.
120B, T120B	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer.	Moderate: silty clay loam surface layer; slopes of 2 to 5 percent.	Moderate: silty clay loam surface layer.
120C2, T120C, 120D2	Moderate: slopes of 5 to 14 percent; silty clay loam surface layer.	Moderate: slopes of 5 to 14 percent; silty clay loam surface layer.	Severe: slopes of 5 to 14 percent.	Moderate: silty clay loam surface layer.
Terril: 27B	Slight	Slight	Moderate: slopes of 2 to 5 percent.	Slight.
Tuskeego: 453	Severe: poorly drained; very slow permeability; subject to flooding.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; very slow permeability; subject to flooding.	Severe: poorly drained; subject to flooding.
Wabash: 172	Severe: very poorly drained; very slow permeability; subject to flooding; silty clay surface layer.	Severe: very poorly drained; subject to flooding; silty clay surface layer.	Severe: very poorly drained; very slow permeability; subject to flooding; silty clay surface layer.	Severe: very poorly drained; subject to flooding; silty clay surface layer.

TABLE 5.—*Use of soils for recreational development*—Continued

Soil series and map symbols	Degree of limitation and major features affecting—			
	Camp areas	Picnic areas	Playgrounds	Paths and trails
Webster: 107	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.
Wiota: 7	Slight	Slight	Slight	Slight.
Zook: 54	Severe: poorly drained; subject to flooding; slow permeability.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding; slow permeability.	Severe: poorly drained; subject to flooding.

OL, and OH, and plastic classes are CL and CH. There is one class of highly organic soils, Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example CL–ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. The estimated classification is given in table 6 for all soils mapped in the survey area.

Soil properties significant to engineering

Estimates of several soil properties significant to engineering are given in table 6. These estimates are made by layers of representative soil profiles having significantly different soil properties. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 6.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in table 6 in the standard terms used by the U.S. Department of Agriculture (USDA). These terms are based on the percentages of sand, silt, and clay in the soil material smaller than 2 millimeters. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the "Glossary" of this soil survey.

Liquid limit and plasticity index are water contents obtained by specified operations. As the water content of a clayey soil from which the particles coarser than 0.5 millimeter have been removed is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from a semisolid to a plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of water content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 6.

Permeability, as used here, is an estimate of the rate at which saturated soil would transmit water in a vertical direction under a unit head of pressure. It is estimated on basis of those soil characteristics observed in the field, particularly structure, porosity, and texture. Lateral seepage or such transient soil features as plowpans and surface crusts are not considered.

Available water capacity is an estimate of the capacity of soils to hold water for use by most plants. It is defined here as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most plants.

Reaction refers to the acidity or alkalinity of a soil, expressed as pH. The pH value and terms used to describe soil reaction are explained in the "Glossary."

Shrink-swell potential refers to the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils may damage building foundations, roads, and other structures. Soils having a *high* shrink-swell potential are the most hazardous.

Depth to bedrock is omitted from table 6. In most of the county the bedrock is considerably deeper than the depths normally investigated, except in the Bauer soils. These soils formed in shale. Also, there are a few small outcrops of sandstone, mostly along Carson Creek near Reasnor.

Engineering interpretations of the soils

The interpretations in table 7 are based on estimated engineering properties of soils shown in table 6, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil

scientists with the soils of Jasper County. In table 7, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than drainage for crops and pasture, irrigation, pond reservoir areas, embankments, and terraces and diversions. For these particular uses, table 7 lists those soil features not to be overlooked in planning, installation, and maintenance.

Bench phases of soils that formed in loess are indicated by a prefix "T" on the map symbol. These soils typically are underlain by stratified alluvium instead of glacial till. In places the alluvium is coarse textured and is at a depth of as little as 5 feet. This should be considered in selecting sites for septic tank absorption fields, sewage lagoons, and sanitary landfills, pond reservoir areas, and other uses that are affected by a porous substratum. Also, the bench phases are a possible source of sand or gravel.

Soil limitations are indicated by the rating slight, moderate, and severe. *Slight* means soil properties are generally favorable for the rated use, or in other words, limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special designs, or intensive maintenance.

Soil suitability is rated by the terms *good, fair,* and *poor,* which have meanings approximately parallel to the terms slight, moderate, and severe.

The following are explanations of some of the colums in table 7:

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material between depths of 18 inches and 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope affects difficulty of layout and construction and also the risk of erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor surrounded by embankments of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic matter content, and slope; and if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified soil classification and the amounts of stones, if any, that influence the ease of excavation and compaction of embankment material.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal periods. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately low permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated the ratings in table 7 apply only to a depth of about 5 feet, and therefore limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but regardless of that, every site should be investigated before it is selected.

Local roads and streets, as rated in table 7, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly of asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material, and also the shrink-swell potential, indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 7 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, and neither do they indicate quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil ma-

TABLE 6.—*Estimates of engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. fully the instructions for referring to other series that appear in the first column of this table. For detailed descriptions of soils, < means

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Ft	*In*			
*Ackmore: 5B, C5B, 430 For Colo parts of 5B and C5B, see Colo series.	3–5	0–15 15–60	Silt loam Silty clay loam	ML or CL CL or CH	A–4 or A–6 A–7
Adair: 192D2	1–3	0–13 13–48 48–60	Clay loam Clay loam Clay loam	CL CH or CL CL	A–6 A–7 A–6 or A–7
*Alluvial land: 315, C315 Most properties are too variable to be estimated. For Nodaway part of 315, see Nodaway series.	1–5	0–60			
Armstrong: 792D2	1–3	0–10 10–14 14–29 29–47 47–60	Loam Clay loam Clay Clay loam Clay loam	ML or CL CL CH CH or CL CL	A–4 or A–6 A–6 A–7 A–7 A–6
Atterberry: 291	2–4	0–15 15–44 44–60	Silt loam Silty clay loam Light silty clay loam	CL CL or CH CL	A–6 A–7 A–7
Bauer: 185E2, 185F2	>5	0–6 6–13 13–37 37–69	Silt loam Silty clay loam Silty clay to clay Clay loam and stratified material includes clayey texture.	CL CH or CL CH CL or CH	A–6 A–7 A–7 A–7
Bolan: 174	>5	0–17 17–38 38–60	Loam Loam and fine sandy loam Loamy fine sand	CL CL and SC SM	A–6 A–4 A–2
Bremer: 43	1–3	0–17 17–34 34–62	Silty clay loam Heavy silty clay loam Heavy silty clay loam	CH or CL CH CH	A–7 A–7 A–7
*Caleb: 94D2, 94E2 For Mystic parts, see Mystic series.	>5	0–9 9–36 36–64	Loam Clay loam Sandy clay loam and sandy loam	CL CL SC or CL	A–6 A–6 or A–7 A–6 or A–4
Canisteo: 507	1–3	0–21 21–36 36–72	Clay loam Loam Loam	CL ML or CL CL	A–6 or A–7 A–6 A–6
*Chelsea: 63C, 63D, 63E, 293G For properties of Fayette soil in mapping unit 293G, refer to the Fayette series.	>5	0–8 8–60	Loamy fine sand Fine sand	SM SM or SP	A–2 A–3 or A–2
Clarinda: 222C2, 222D2	1–3	0–6 6–25 25–60	Silty clay loam Silty clay and clay Silty clay	CL or ML CH CH	A–6 or A–7 A–7 A–7
Clarion: 138B, 138C2, 138D2, 138E2.	>5	0–12 12–32 32–60	Loam Loam Loam	CL or ML CL or ML CL or ML	A–4 or A–6 A–4 or A–6 A–4 or A–6
Clinton: 80C2, 80D2, 80E2, 80D3	>5	0–9 9–46 46–62	Silt loam Silty clay loam Silty clay loam	ML or CL or CL–ML CL or CH CL	A–4 or A–6 A–7 A–7

properties of soils

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow care-
see section "Descriptions of the Soils." Absence of data indicates that no estimate was made. The symbol > means greater than;
less than]

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Pct		*In/hr*	*In/in of soil*	*pH*	
100	95–100	90–100	70–90	30–40	5–15	0.6–2.0	0.22–0.24	6.1–7.3	Moderate.
100	100	95–100	85–100	41–55	20–30	0.2–0.6	0.18–0.20	5.6–7.3	High.
95–100	95–100	90–95	70–80	30–40	11–20	0.2–0.6	0.17–0.19	6.1–7.3	Moderate.
95–100	95–100	90–100	75–90	41–55	20–35	0.06–0.2	0.14–0.16	5.6–6.0	High.
95–100	95–100	90–100	70–80	35–50	20–30	0.06–0.2	0.14–0.16	6.6–7.3	Moderate.
100	100	----------	----------	----------	----------	----------	----------	5.6–6.8	
100	100	85–95	60–75	25–35	5–15	0.6–2.0	0.20–0.22	6.1–6.5	Low.
100	100	90–100	70–80	30–40	11–20	0.2–0.6	0.17–0.19	6.1–6.5	Moderate.
100	100	90–100	75–95	50–60	20–35	0.06–0.2	0.11–0.13	5.1–6.0	High.
100	100	90–100	70–80	41–55	20–35	0.2–0.6	0.12–0.14	5.6–6.0	High.
100	100	90–100	70–80	30–40	11–20	0.2–0.6	0.14–0.16	6.6–7.3	Moderate.
100	100	90–100	85–95	30–40	11–20	0.6–2.0	0.22–0.24	6.1–6.5	Moderate.
100	100	95–100	85–95	41–55	20–35	0.6–2.0	0.18–0.20	5.6–6.5	High.
100	100	95–100	85–95	30–40	20–30	0.6–2.0	0.18–0.20	5.6–6.0	Moderate.
100	100	90–100	80–95	30–40	15–25	0.2–0.6	0.22–0.24	5.6–6.5	Moderate.
100	100	95–100	85–95	41–55	15–30	0.2–0.6	0.21–0.23	5.6–6.0	High.
100	100	95–100	90–95	50–65	20–35	<0.06	0.11–0.13	5.6–7.3	High.
100	100	95–100	90–95	40–55	20–35	<0.06	0.08–0.16	6.6–7.3	High.
100	100	85–95	60–75	25–35	11–20	0.6–2.0	0.18	6.1–7.3	Low.
100	100	70–95	35–60	20–35	5–15	0.6–6.0	0.15	6.1–6.5	Low.
100	100	90–95	10–35	<20	[1] NP	6.0–20.0	0.08	6.1–6.5	High.
100	100	100	95–100	41–60	20–35	0.2–0.6	0.21–0.23	6.1–6.5	High.
100	100	95–100	95–100	50–65	25–40	0.06–0.6	0.15–0.17	6.1–6.5	High.
100	100	95–100	95–100	50–65	25–40	0.06–0.6	0.15–0.17	6.1–6.5	High.
100	100	85–95	60–75	30–40	5–15	0.6–2.0	0.14	5.6–6.0	Low.
100	100	90–100	70–80	35–50	20–35	0.2–2.0	0.16	5.6–6.0	Moderate.
100	100	80–90	35–60	25–40	5–15	0.6–2.0	0.14	5.6–6.0	Low.
100	100	90–100	70–95	35–45	11–20	0.6–2.0	0.21–0.23	7.4–7.8	Moderate.
100	100	85–95	60–75	25–40	11–20	0.6–2.0	0.18–0.20	7.9–8.4	Moderate.
100	100	85–95	60–75	25–40	11–20	0.6–2.0	0.17–0.19	7.9–8.4	Low.
100	95–100	80–95	10–35	<20	NP	2.0–6.0	0.10–0.12	5.6–6.0	Low.
100	95–100	80–95	3–15	<20	NP	6.0–20.0	0.06–0.08	5.1–6.0	Very low.
100	95–100	90–100	85–100	35–45	15–25	0.2–0.6	0.21–0.23	6.1–6.5	Moderate.
100	95–100	90–100	85–100	50–65	30–40	<0.06	0.11–0.13	5.6–6.5	High.
95–100	90–100	80–95	75–90	50–65	30–40	<0.06	0.11–0.13	6.1–6.5	High.
95–100	95–100	75–90	55–75	25–40	5–15	0.6–2.0	0.20–0.22	6.6–7.3	Low.
95–100	95–100	75–90	55–75	25–40	5–15	0.6–2.0	0.17–0.19	6.1–6.5	Low.
90–100	85–100	75–90	50–75	25–40	5–15	0.6–2.0	0.17–0.19	6.1–7.8	Low.
100	100	95–100	85–100	25–40	5–15	0.6–2.0	0.22–0.24	5.1–6.0	Low.
100	100	95–100	85–100	41–55	20–30	0.2–0.6	0.18–0.20	5.1–6.0	High.
100	100	95–100	80–100	35–45	15–25	0.6–2.0	0.19–0.21	5.1–5.5	Moderate.

TABLE 6.—*Estimates of engineering*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Ft	*In*			
Coland: 135, 135B	1–3	0–39	Clay loam and sandy clay loam	CL	A–6
		39–49	Sandy clay loam	CL	A–6
		49–61	Sandy clay loam	SC or CL	A–6
Colo: 133, 133+	1–3	0–40	Silty clay loam	CL or CH	A–7
		40–60	Silty clay loam	CL or CH	A–7
Dickinson: 175B, 175C, 175D	>5	0–24	Fine sandy loam	SM or SC	A–4
		24–50	Loamy sand and sand	SM	A–2
		50–60	Loamy sand	SM	A–2
Downs: 162, 162B, 162C2, 162D2, 162E2, T162B, T162C.	>5	0–8	Silt loam	CL–ML, ML or CL	A–4 or A–6
		8–39	Silty clay loam	CL	A–7 or A–6
		39–60	Silt loam	CL	A–6
Ely: 428B	3–5	0–24	Silty clay loam	CL	A–7
		24–60	Silty clay loam	CL	A–7 or A–6
Fayette: 163B, 163C2, 163D2, 163E2, 163F2, 163D3.	>5	0–7	Silt loam	CL–ML or ML	A–4 or A–6
		7–45	Silty clay loam	CL	A–7 or A–6
		45–65	Silt loam	CL	A–6
Flagler: 284B	>5	0–15	Sandy loam	SM or SC	A–4 or A–2
		15–32	Sandy loam	SM or SC	A–4 or A–2
		32–60	Loamy sand with some coarse sand and gravel.	SW, SP, or SW–SM	A–1–b
*Gara: 179D2, 179E2, 179F2, 179G, 993D2, 993E2, 993E3. For Armstrong parts of 993D2, 993E2, and 993E3, see Armstrong series.	>5	0–12	Loam	CL	A–6
		12–38	Clay loam	CL	A–7 or A–6
		38–60	Clay loam	CL	A–7 or A–6
*Garwin: 118, 117 For Sperry part of 117, see Sperry series.	1–3	0–17	Silty clay loam	CL	A–7
		17–49	Silty clay loam	CL or CH	A–7
		49–60	Silt loam	CL	A–6 or A–7
Hayden: 168E2, 168F, 168G	>5	0–9	Loam	CL or ML	A–6 or A–4
		9–41	Clay loam	CL	A–6 or A–7
		41–61	Clay loam	CL	A–6 or A–7
Judson: 8, 8B, 8C	>5	0–24	Silty clay loam	CL	A–7 or A–6
		24–62	Silty clay loam	CL	A–7 or A–6
Kennebec: 212	3–5	0–50	Silt loam or silty clay loam	CL or ML	A–6 or A–7
		50–60	Silty clay loam	CL	A–6 or A–7
Killduff: 20C2, 20D2, 20E2	>5	0–11	Silty clay loam	ML or CL	A–7 or A–6
		11–36	Silty clay loam	CL	A–7
		36–60	Silt loam	CL	A–6
Ladoga: 76B, 76C2, 76D2	>5	0–11	Silt loam	ML or CL	A–6 or A–4
		11–60	Silty clay loam	CH or CL	A–7
Lamoni: 822D2, 822E2	1–3	0–10	Silty clay loam	CL	A–6 or A–7
		10–37	Clay	CH	A–7
		37–60	Clay loam	CL or CH	A–7
Lawler: 226, 225	3–5	0–20	Loam	CL	A–6
		20–35	Heavy loam and light sandy clay loam.	CL or SC	A–6
		35–60	Sandy loam and fine gravel	SM, SP, or SW	A–2–4 or A–1
Lester: 236B, 236C2, 236D2	>5	0–9	Loam	CL–ML or CL	A–4 or A–6
		9–36	Clay loam	CL	A–6 or A–7
		36–60	Loam	CL–ML or CL	A–4 or A–6

properties of soils—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Pct		*In/hr*	*In/in of soil*	*pH*	
95–100	80–100	75–90	55–85	25–40	11–20	0.2–0.6	0.18–0.22	6.6–7.3	Moderate.
100	95–100	90–100	85–100	25–40	11–20	0.2–0.6	0.18–0.22	7.4–7.8	Moderate.
95–100	80–100	70–85	50–80	25–40	5–15	0.6–2.0	0.16–0.20	6.1–7.3	Low.
----------	100	95–100	95–100	41–60	15–30	0.2–0.6	0.21–0.23	6.1–7.3	High.
----------	100	90–100	90–100	41–60	15–30	0.2–0.6	0.18–0.20	6.6–7.3	High.
----------	100	85–95	35–50	15–30	5–10	2.0–6.0	0.12–0.15	5.1–6.0	Low.
----------	100	70–95	3–20	<20	<10	6.0–>20.0	0.08–0.10	6.6–7.3	Very low.
----------	100	80–95	3–20	<20	<10	6.0–20.0	0.02–0.04	6.1–6.5	Very low.
----------	100	95–100	95–100	30–40	5–15	0.6–2.0	0.21–0.23	5.6–6.1	Low.
----------	100	95–100	95–100	35–45	15–25	0.6–2.0	0.18–0.20	5.1–6.5	Moderate.
----------	100	95–100	95–100	30–40	11–20	0.6–2.0	0.18–0.20	6.6–7.3	Moderate.
100	100	95–100	85–95	41–50	15–25	0.6–2.0	0.20–0.22	5.6–6.5	Moderate.
100	100	95–100	85–95	35–45	11–20	0.6–2.0	0.18–0.20	6.6–7.3	Moderate.
100	100	95–100	95–100	25–35	5–15	0.6–2.0	0.20–0.22	5.6–6.5	Low.
100	100	95–100	95–100	35–45	15–25	0.6–2.0	0.18–0.20	5.1–6.0	Moderate.
100	100	95–100	95–100	30–40	11–20	0.6–2.0	0.18–0.20	5.6–6.0	Moderate.
95–100	90–95	60–70	25–40	15–25	5–10	2.0–6.0	0.12–0.14	5.1–6.5	Low.
95–100	90–95	50–70	25–40	15–25	5–10	2.0–6.0	0.11–0.13	6.1–7.3	Low.
70–90	70–85	20–40	3–12	NP	NP	>20.0	0.02–0.04	6.6–7.8	Very low.
95–100	95–100	85–95	75–85	25–40	11–20	0.6–2.0	0.20–0.22	5.1–7.3	Low.
95–100	95–100	90–100	75–85	35–50	20–30	0.2–0.6	0.16–0.18	5.6–6.0	Moderate.
95–100	95–100	90–100	75–85	35–50	20–30	0.2–0.6	0.16–0.18	7.4–7.8	Moderate.
100	100	100	95–100	41–50	15–25	0.2–0.6	0.21–0.23	5.6–6.5	Moderate.
100	100	100	95–100	45–55	25–35	0.2–0.6	0.18–0.20	6.1–7.3	High.
100	100	100	95–100	35–45	15–25	0.6–2.0	0.20–0.22	7.4–7.8	Moderate.
100	95–100	80–95	50–75	20–35	5–15	0.6–2.0	0.20–0.22	5.6–6.5	Low.
95–100	85–100	75–85	60–85	35–50	15–25	0.6–2.0	0.15–0.19	5.6–6.5	Moderate.
95–100	85–100	75–85	50–80	30–50	11–25	0.6–2.0	0.14–0.16	6.1–6.5	Moderate.
100	100	95–100	95–100	30–50	15–25	0.6–2.0	0.21–0.23	6.1–6.5	Moderate.
100	100	95–100	95–100	30–50	15–25	0.6–2.0	0.18–0.20	6.1–7.3	Moderate.
100	100	90–100	95–100	35–45	15–25	0.6–2.0	0.18–0.22	6.1–6.5	Moderate.
100	100	90–100	70–90	30–45	11–20	0.6–2.0	0.18–0.20	6.6–7.3	Moderate.
100	100	100	95–100	35–50	15–25	0.6–2.0	0.21–0.23	6.1–7.3	Moderate.
100	100	100	95–100	41–50	15–25	0.6–2.0	0.18–0.20	5.6–6.0	Moderate.
100	100	100	95–100	30–40	11–20	0.6–2.0	0.20–0.22	5.6–6.5	Moderate.
100	100	95–100	95–100	30–40	5–15	0.6–2.0	0.22–0.24	5.6–7.3	Low.
100	100	95–100	95–100	40–55	15–25	0.2–0.6	0.18–0.20	5.6–7.3	High.
100	100	95–100	75–95	35–45	11–20	0.2–0.6	0.21–0.23	5.6–6.5	Moderate.
100	100	90–100	75–95	50–65	30–40	<0.06–0.2	0.11–0.13	5.6–6.5	High.
100	100	90–100	70–80	41–55	23–35	0.06–0.2	0.14–0.16	6.6–7.3	High.
100	90–100	70–90	55–75	35–40	15–25	0.6–2.0	0.20–0.22	6.1–6.5	Low.
95–100	90–95	70–90	45–65	25–35	11–20	0.6–2.0	0.16–0.18	6.1–6.5	Low.
70–90	40–80	25–40	3–25	5–10	5–15	6.0–>20.0	0.02–0.04	6.6–7.3	Very low.
95–100	90–100	80–95	60–80	20–35	5–15	0.6–2.0	0.20–0.22	6.1–7.3	Low.
95–100	90–100	85–95	70–80	35–45	15–25	0.6–2.0	0.15–0.19	5.1–6.5	Moderate.
95–100	90–100	75–90	60–75	30–40	8–14	0.6–2.0	0.17–0.19	5.1–7.8	Moderate.

TABLE 6.—*Estimates of engineering*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Ft	*In*			
Lindley: 65E, 65E3, 65F, 65G	>5	0–9	Loam	CL, ML, or CL–ML	A–4 or A–6
		9–18	Loam or clay loam	CL	A–6 or A–7
		18–60	Clay loam	CL	A–6 or A–7
Mahaska: 280	2–4	0–22	Silty clay loam	ML or CL	A–7
		22–48	Silty clay loam	CH	A–7
		48–60	Silty clay loam	CL	A–7
Marsh: 354. Properties too variable to be estimated.					
Martinsburg: 742B, 742C	>5	0–16	Silt loam	CL–ML, ML, or CL	A–4
		16–60	Silt loam or silty clay loam	CL	A–6 or A–7
Muscatine: 119	3–5	0–18	Silty clay loam	CL or ML	A–7
		18–47	Silty clay loam	CL	A–7
		47–72	Silty clay loam	CL	A–7 or A–6
Mystic	1–3	0–6	Clay loam	ML or CL	A–4 or A–6
Mapped only with Caleb soils.		6–41	Clay loam	CL or CH	A–6 or A–7
		41–60	Clay loam	CL or CH	A–6 or A–7
Nevin: 88	2–4	0–22	Silty clay loam	CL or ML	A–6 or A–7
		22–53	Silty clay loam	CL	A–7
		53–60	Silty clay loam	CL	A–6 or A–7
Nicollet: 55	3–5	0–18	Loam or clay loam	CL–ML, ML, or CL	A–6 or A–7
		18–37	Clay loam	CL	A–6 or A–7
		37–72	Loam	CL–ML, ML, or CL	A–4 or A–6
Nira: 570B2, 570C2, 570D2	>5	0–18	Silty clay loam	ML or CL	A–7 or A–6
		18–42	Silty clay loam	CL	A–7
		42–60	Silt loam	CL	A–6
Nodaway: 220	3–5	0–60	Silt loam	ML or CL	A–6
Olmitz: 273B, 273C	>5	0–24	Loam	CL	A–6
		24–60	Clay loam	CL	A–6 or A–7
Otley: 281B, 281C2, 281D2	>5	0–18	Silty clay loam	CL	A–6 or A–7
		18–39	Silty clay loam	CH	A–7
		39–60	Silty clay loam	CL	A–7
Port Byron: 620C2, 620D2, 620E2, 620F2.	>5	0–7	Silt loam	ML, CL, or CL–ML	A–4 or A–6
		7–35	Silt loam	CL	A–6
		35–60	Silt loam	ML, CL, or CL–ML	A–4 or A–6
*Shelby: 24D2, 24E2, 24F2, 93D2, 93E2. For Adair parts of 93D2 and 93E2, see Adair series.	>5	0–6	Loam	CL	A–6 or A–7
		6–48	Clay loam	CL	A–6 or A–7
		48–60	Clay loam	CL	A–6 or A–7
Sparta: 41B, 41C2, 41D2	>5	0–16	Loamy fine sand and sandy loam	SM	A–2
		16–38	Loamy sand and sandy loam	SM	A–2
		38–69	Loamy sand	SM	A–2
Sperry: 122	0–3	0–10	Silt loam	ML or CL	A–6 or A–4
		10–17	Silt loam	ML or CL	A–6 or A–4
		17–48	Silty clay loam	CH	A–7
		48–60	Silty clay loam	CH or CL	A–7 or A–6

properties of soils—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Pct		*In/hr*	*In/in of soil*	*pH*	
95–100	95–100	80–95	50–60	20–35	5–15	0.6–2.0	0.20–0.22	6.1–6.5	Low.
95–100	95–100	80–95	55–70	35–50	15–25	0.2–0.6	0.15–0.19	5.6–6.0	Moderate.
90–100	85–95	80–90	55–70	30–45	15–25	0.2–0.6	0.14–0.16	5.1–5.5	Moderate.
100	100	95–100	95–100	41–50	15–25	0.6–2.0	0.21–0.23	5.1–5.5	Moderate.
100	100	95–100	95–100	50–60	25–35	0.2–0.6	0.14–0.16	5.1–5.5	Moderate.
100	100	100	95–100	41–50	15–25	0.6–2.0	0.18–0.20	5.6–6.0	Moderate.
100	100	94–100	90–100	15–30	5–20	0.6–2.0	0.22–0.24	5.6–6.0	Low.
100	100	94–100	90–100	30–40	11–20	0.6–2.0	0.18–0.20	5.6–6.0	Moderate.
100	100	94–100	94–100	41–50	15–25	0.6–2.0	0.21–0.23	5.6–6.0	Moderate.
100	100	100	94–100	41–50	25–35	0.6–2.0	0.18–0.20	5.6–6.5	Moderate.
100	100	100	95–100	35–45	25–35	0.6–2.0	0.18–0.20	6.1–6.5	Moderate.
100	100	95–100	80–100	30–40	5–15	0.06–0.2	0.17–0.19	6.1–6.5	Low.
100	95–100	80–95	65–80	35–55	15–30	0.06–0.2	0.15–0.19	5.6–6.0	High.
100	95–100	80–95	65–80	35–55	15–30	0.06–0.2	0.14–0.16	6.1–6.5	High.
100	95–100	90–100	90–100	35–45	11–20	0.2–2.0	0.21–0.23	6.1–7.3	Moderate.
100	95–100	90–100	90–100	41–50	20–30	0.2–2.0	0.18–0.20	6.6–7.3	Moderate.
100	95–100	90–100	90–100	35–50	20–30	0.2–2.0	0.18–0.20	6.6–7.3	Moderate.
95–100	95–100	85–95	60–80	35–45	11–20	0.6–2.0	0.19–0.21	5.6–6.5	Moderate.
95–100	90–100	80–95	60–80	35–45	11–20	0.6–2.0	0.15–0.19	6.1–6.5	Moderate.
90–100	85–95	75–90	60–75	30–40	5–20	0.6–2.0	0.17–0.19	6.6–7.8	Low.
100	100	95–100	95–100	35–45	15–25	0.6–2.0	0.21–0.23	6.1–6.5	Moderate.
100	100	95–100	95–100	41–50	20–30	0.2–0.6	0.18–0.20	6.6–7.3	Moderate.
100	100	90–100	95–100	35–40	15–25	0.6–2.0	0.20–0.22	7.4–7.8	Moderate.
100	96–100	90–100	80–90	30–40	11–20	0.6–2.0	0.20–0.24	6.6–7.3	Moderate.
100	90–100	90–95	60–80	30–40	15–25	0.6–2.0	0.18–0.21	5.6–6.5	Low.
100	90–100	90–95	60–80	35–50	15–25	0.6–2.0	0.15–0.17	5.6–6.0	Moderate.
100	100	100	95–100	35–45	15–25	0.2–2.0	0.21–0.23	5.6–6.5	Moderate.
100	100	100	95–100	41–50	20–30	0.2–0.6	0.18–0.20	5.6–6.5	High.
100	100	100	95–100	35–45	15–25	0.2–0.6	0.18–0.20	5.6–6.5	Moderate.
100	100	95–100	90–100	25–40	5–15	0.6–2.0	0.22–0.24	6.6–7.3	Low.
100	100	95–100	90–100	30–40	11–20	0.6–2.0	0.20–0.22	6.1–6.5	Low.
100	100	95–100	90–100	25–40	5–15	0.6–2.0	0.20–0.22	6.1–6.5	Low.
90–100	85–98	70–85	60–80	30–45	15–25	0.6–2.0	0.20–0.22	6.6–7.3	Moderate.
90–100	85–98	70–85	60–80	35–50	20–30	0.2–0.6	0.15–0.19	6.1–6.6	Moderate.
90–100	85–98	70–85	60–80	30–45	20–30	0.2–0.6	0.14–0.16	6.6–7.3	Moderate.
100	100	80–90	10–35	>20	5–10	>20.0	0.11–0.14	6.1–6.5	Low.
100	100	60–70	10–15	>20	5–10	>20.0	0.13–0.16	6.1–6.5	Low.
100	100	60–70	5–10	>20	5–10	>20.0	0.08–0.10	6.1–6.5	Low.
100	100	95–100	95–100	30–40	5–10	0.6–2.0	0.22–0.24	6.6–7.3	Low.
100	100	95–100	95–100	30–40	5–15	0.2–0.6	0.20–0.22	6.6–7.3	Low.
100	100	95–100	95–100	50–65	25–35	0.06–0.2	0.18–0.20	6.6–7.3	High.
100	100	95–100	95–190	35–55	20–30	0.06–0.2	0.18–0.20	6.6–7.3	Moderate.

TABLE 6.—*Estimates of engineering*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHTO
	Ft	*In*			
Storden: 62D, 62E, 62F	>5	0–8	Loam	ML or CL	A–4 or A–6
		8–60	Loam	CL–ML or CL	A–6 or A–4
Taintor: 279	1–3	0–14	Silty clay loam	CL	A–7
		14–44	Silty clay loam	CH	A–7
		44–60	Silty clay loam	CL or CH	A–7
Tama: 120, 120B, 120C2, 120D2, T120B, T120C.	>5	0–15	Silty clay loam	ML or CL	A–7 or A–6
		15–42	Silty clay loam	CL	A–7
		42–60	Silty clay loam	CL	A–7 or A–6
Terril: 27B	>5	0–30	Loam or clay loam	CL–ML, ML, or CL	A–6 or A–4
		30–60	Loam or clay loam	CL–ML, ML, or CL	A–6 or A–4
Tuskeego: 453	1–3	0–24	Silt loam	ML or CL	A–4 or A–6
		24–48	Silty clay to silty clay loam	CL or CH	A–7
		48–65	Silty clay loam	CL	A–7
Wabash: 172	1–3	0–24	Silty clay	CH	A–7
		24–60	Silty clay	CH	A–7
Webster: 107	1–3	0–17	Silty clay loam	CL	A–7 or A–6
		17–47	Silty clay loam	CL	A–7 or A–6
		47–60	Loam	CL	A–6
Wiota: 7	>5	0–20	Silt loam or silty clay loam	CL	A–6
		20–46	Silty clay loam	CL or CH	A–6 or A–7
		46–60	Silty clay loam	CL	A–6 or A–7
Zook: 54	1–3	0–37	Silty clay loam and silty clay	CH or CL	A–7
		37–60	Silty clay	CH	A–7

[1] NP means nonplastic.

terial resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are unfavorable factors.

Drainage for crops and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope, stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slopes; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; need for drainage; and depth to water table or bedrock.

Terraces and diversions are embankments or ridges constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provide outlet for runoff and is not difficult to vegetate.

Formation and classification of the soils

In this section the factors that have affected the formation of the soils in Jasper County are discussed, and the classification of the soils by higher categories is explained. Detailed descriptions of soil profiles considered representative of the series are given in the section "Description of the Soils."

Factors of soil formation

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal

properties of soils—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				Pct		*In/hr*	*In/in of soil*	*pH*	
95–100	95–100	70–85	55–70	25–40	5–15	0.6–2.0	0.20–0.22	6.6–7.3	Low.
95–100	85–95	70–85	55–70	25–40	5–15	0.6–2.0	0.17–0.19	7.9–8.4	Low.
100	100	95–100	95–100	41–50	15–25	0.2–0.6	0.21–0.23	5.6–6.0	Moderate.
100	100	95–100	95–100	50–60	25–35	0.06–0.6	0.18–0.20	5.1–6.0	High.
100	100	95–100	90–100	45–55	25–35	0.06–0.6	0.18–0.20	5.6–6.0	High.
100	100	100	95–100	35–50	11–20	0.6–2.0	0.21–0.23	6.1–7.3	Moderate.
100	100	100	95–100	41–50	15–25	0.6–2.0	0.18–0.20	5.6–6.5	Moderate.
100	100	100	95–100	35–45	15–25	0.6–2.0	0.18–0.20	5.6–6.0	Moderate.
100	95–100	70–90	60–80	25–40	5–20	0.6–2.0	0.17–0.19	6.1–7.3	Low.
100	95–100	70–90	60–80	25–40	5–20	0.6–2.0	0.16–0.18	6.6–7.8	Low.
100	100	95–100	95–100	30–45	8–20	0.6–2.0	0.21–0.23	5.6–7.3	Moderate.
100	100	95–100	95–100	41–55	25–35	<0.06	0.12–0.19	6.6–7.3	High.
100	100	95–100	95–100	41–50	20–30	0.06–0.2	0.18–0.20	6.6–7.3	Moderate.
100	100	95–100	95–100	60–85	45–55	<0.06	0.11–0.13	6.1–7.3	High.
100	100	95–100	95–100	60–85	40–50	<0.06	0.11–0.13	6.6–7.3	High.
100	95–100	85–95	70–90	35–45	15–30	0.2–2.0	0.21–0.23	6.6–7.3	Moderate.
100	95–100	85–95	70–90	35–50	15–35	0.2–2.0	0.18–0.20	6.6–7.3	Moderate.
95–100	90–100	75–85	60–75	30–40	11–25	0.6–2.0	0.17–0.19	6.6–7.3	Moderate.
100	100	95–100	90–100	30–40	11–20	0.6–2.0	0.19–0.22	6.1–7.3	Moderate.
100	100	95–100	90–100	35–55	15–30	0.6–2.0	0.18–0.20	5.6–6.5	Moderate.
100	100	85–100	80–95	30–45	11–20	0.6–2.0	0.18–0.20	5.6–6.0	Moderate.
100	100	95–100	95–100	41–60	20–40	0.2–0.6	0.19–0.22	6.1–6.5	High.
100	100	95–100	95–100	50–65	35–45	0.06–0.2	0.11–0.13	6.1–7.3	High.

life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil formation have acted on the soil material.

Climate and vegetation are active factors of soil genesis. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for the parent material to change into a soil profile. It may be a long or short time, but some time is always required for horizon differentiation. Generally a long time is required for the development of distinct horizons.

The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material

The principal parent materials in Jasper County are loess, glacial till, and alluvium (fig. 17). Less extensive parent materials are sand and residium weathered in place from shale.

Loess is the most extensive parent material in the county. It is a yellowish brown, wind-deposited material that consists largely of silt particles. It contains smaller amounts of clay and sand. Unweathered loess is silt loam or light silty clay loam in texture. Radiocarbon dating indicates that the loess was deposited between about 14,000 and 29,000 years ago (*8*). On the stable divides in Jasper County it ranges from about 10 feet to 23 feet in thickness. It is thinner on the slopes where part or all of the loess has been removed by geological erosion. The loess thins from north to south with increasing distance from the sources. The major source of loess for southern Iowa is considered to be the Missouri River Valley. Another source of loess for Jasper County was erosional surfaces to the north that have since been covered by glacial deposits. Some of the major soils that formed in loess are Clinton, Downs, Fayette, Garwin, Killduff, Ladoga, Mahaska, Muscatine, Nira, Otley, Taintor, and Tama soils.

Some of these soils formed partly in loess that was weathered during different climatic periods than have existed recently (*7*). This loess is characterized by

TABLE 7.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The instructions for referring to other series that appear in the first column of this

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
*Ackmore: 5B, C5B, 430 ---------- For Colo parts of 5B and C5B, see Colo series.	Severe: seasonal high water table; subject to flooding.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; susceptible to frost action; low strength.	Poor: low strength; high to moderate shrink-swell potential; susceptible to frost action; somewhat poorly drained.
Adair: 192D2 ----------	Severe: slow permeability; seasonal high water table; slopes of 9 to 18 percent.	Severe: slopes of 9 to 18 percent.	Severe: seasonal high water table; moderately well drained or somewhat poorly drained; clay loam.	Severe: high shrink-swell potential; highly susceptible to frost action; moderately well drained to somewhat poorly drained.	Poor: high shrink-swell potential; susceptible to frost action.
*Alluvial land: 315, C315 ---------- For Nodaway part of 315, see Nodaway series.	Severe: subject to frequent flooding.	Severe: seasonal high water table; subject to flooding.	Severe: subject to flooding; seasonal high water table.	(1) ----------	Variable: strata of fine and very fine sands in places.
Armstrong: 792D2 ----------	Severe: slow permeability; seasonal high water table; slopes of 9 to 18 percent.	Severe: slopes of 9 to 18 percent.	Severe: seasonal high water table; slopes of 9 to 18 percent.	Severe: high shrink-swell potential; highly susceptible to frost action; slopes of 9 to 18 percent.	Poor: high shrink-swell potential; highly susceptible to frost action.

interpretations

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the table. For detailed descriptions of soils, see section "Descriptions of the Soils"]

Suitability as source of—continued		Soil features affecting—				
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Unsuitable	Good	Moderately slow permeability; seasonal high water table at a depth of 3 to 5 feet.	Medium to low strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair compaction characteristics.	Moderately slow permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent.	Slopes of 0 to 2 percent; somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet; susceptible to stream overflow; moderately slow permeability.	Slopes of 0 to 2 percent on bottom lands.
Unsuitable	Fair: clay loam; topsoil about 10 inches thick; slopes of 9 to 18 percent.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to 18 percent.	Low to medium shear strength and susceptibility to piping; medium to high compressibility; low permeability of compacted soils; fair compaction characteristics.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to 18 percent.	Slopes of 9 to 18 percent; seasonal high water table at a depth of 1 foot to 3 feet; subject to erosion; slow permeability.	Slopes of 9 to 18 percent; subject to erosion; firm clay loam subsoil; slow permeability; difficult to vegetate.
Variable: strata of fine and very fine sand in places.	Fair to good: generally variable; subject to flooding.	Variable soil properties; fluctuating water table; subject to flooding; slopes of 0 to 2 percent.	Generally low to medium shear strength; medium compressibility; medium to low compacted permeability; medium susceptibility to piping; fair compaction characteristics.	Variable permeability and texture; frequent flooding; slopes of 0 to 2 percent.	Slopes of 0 to 2 percent; subject to flooding; variable permeability.	Slopes of 0 to 2 percent on bottom lands.
Unsuitable	Fair: generally 10 inches of topsoil; slopes of 9 to 18 percent.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to 18 percent.	Medium to low shear strength; low compacted permeability; medium to high compressibility; low to medium susceptibility to piping; fair compaction characteristics.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to 18 percent.	Slopes of 9 to 18 percent; seasonal high water table at a depth of 1 foot to 3 feet; slow permeability; subject to erosion.	Slopes of 9 to 18 percent; subject to erosion.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
Atterberry: 291	Severe: seasonal high water table.	Severe: seasonal high water table.	Severe: seasonal high water table; moderate permeability.	Severe: somewhat poorly drained; susceptible to frost action.	Poor: moderate shrink-swell potential; highly susceptible to frost action; somewhat poorly drained.
Bauer: 185E2, 185F2	Severe: very slow permeability; unsatisfactory percolation rates; slopes of 9 to 40 percent.	Severe: slopes of 9 to 40 percent.	Severe: silty clay or clay; slopes of 9 to 40 percent.	Severe: slopes of 9 to 40 percent; high shrink-swell potential.	Poor: high shrink-swell potential; highly susceptible to frost action.
Bolan: 174	Slight: danger of ground water contamination.	Severe: moderate to rapid permeability.	Severe: moderate to rapid permeability.	Slight	Good: good below a depth of about 2 feet.
Bremer: 43	Severe: slow to moderately slow permeability; seasonal water table at a depth of 1 foot to 3 feet; subject to flooding.	Severe: seasonal water table at a depth of 1 foot to 3 feet; subject to flooding; high organic matter content.	Severe: poorly drained; subject to flooding; heavy silty clay loam subsoil.	Severe: poorly drained; subject to flooding; susceptible to frost action.	Poor: high shrink-swell potential; poorly drained; susceptible to frost action.
*Caleb: 94D2, 94E2 For Mystic parts, see Mystic series.	Severe: moderate to moderately slow permeability; slopes of 9 to 18 percent.	Severe: slopes of 9 to 18 percent; variable permeability in stratified material.	Severe: variable permeability in stratified material.	Severe: slopes of 9 to 18 percent; moderate shrink-swell potential.	Fair: moderate shrink-swell potential; slopes of 9 to 18 percent.

interpretations—Continued

Suitability as source of—continued		Soil features affecting—				
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Unsuitable	Good	Moderate permeability; seasonal high water table; slopes of 0 to 2 percent.	Medium to low shear strength and permeability of compacted soils; medium to high compressibility; susceptible to piping; fair compaction characteristics.	Moderate permeability; seasonal high water table.	High available water capacity; moderate permeability.	Slopes of 0 to 2 percent; moderate permeability.
Unsuitable	Poor: generally less than 8 inches of topsoil; slopes of 9 to 40 percent.	Very slow permeability; shale bedrock at a depth of about 37 inches; slopes of 9 to 40 percent.	Low shear strength; high compressibility; low compacted permeability; low susceptibility to piping; poor compaction characteristics.	Adequate natural drainage.	Slopes of 9 to 40 percent; clayey shales in lower subsoil; very slow permeability; subject to erosion.	Slopes of 9 to 40 percent; shale bedrock at a depth of about 37 inches; subject to erosion; very slow permeability; difficult to vegetate.
Fair: no gravel.	Good: loam; slopes of 0 to 2 percent.	Rapid permeability in lower part of subsoil and in substratum.	Medium to low shear strength and compressibility; low permeability of compacted soil; medium to low susceptibility to piping; fair to good compaction characteristics.	Adequate natural drainage.	Moderate available water capacity; slopes of 0 to 2 percent; well drained.	Slopes of 0 to 2 percent on stream benches; hazard of soil blowing; loam and fine sandy loam; rapid permeability on lower part.
Unsuitable	Poor: poorly drained; silty clay loam.	Slow to moderately slow permeability; seasonal water table at a depth of 1 foot to 4 feet; slopes of 0 to 2 percent.	Medium to low shear strength; high compressibility; low permeability of compacted soil and susceptibility to piping; fair to poor compacpaction characteristics.	Slow to moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent; occasional flooding; outlets difficult to determine.	High available water capacity; slopes of 0 to 2 percent; poorly drained; seasonal high water table at a depth of 1 foot to 4 feet; slow to moderately slow permeability.	Slopes of 0 to 2 percent; slow to moderately slow permeability; silty clay loam on stream benches.
Fair: pockets of well graded sand substratum in places.	Fair: loam to a depth of 9 inches; slopes of 9 to 18 percent.	Variable permeability in stratified material; possible seepage; slopes of 9 to 18 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Adequate natural drainage.	Moderate available water capacity; slopes of 9 to 18 percent; variable permeability in stratified materials; subject to erosion.	Slopes of 9 to 18 percent; subsoil and substratum sandy and gravelly in places; subject to erosion; hard to vegetate.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
Canisteo: 507	Severe: moderate permeability; seasonal water table at a depth of 1 foot to 3 feet.	Severe: seasonal high water table at a depth of 1 foot to 3 feet; high organic matter content.	Severe: seasonal high water table at a depth of 1 foot to 3 feet; poorly drained.	Severe: poorly drained; susceptible to frost action.	Poor: moderate shrink-swell potential; susceptible to frost action.
*Chelsea: 63C, 63D, 63E, 293G For Fayette part of 293G, see Fayette series.	Moderate if slopes are less than 14 percent. Severe if slopes are more than 14 percent: danger of ground water contamination.	Severe: rapid permeability; slopes of 4 to 40 percent.	Severe: rapid permeability; slopes of 4 to 40 percent.	Moderate if slopes are less than 14 percent. Severe if slopes are more than 14 percent.	Good if slopes are less than 14 percent. Severe if slopes are more than 14 percent.
Clarinda: 222C2, 222D2	Severe: very slow permeability; seasonal high water table.	Severe: seasonal high water table; slopes of 5 to 14 percent.	Severe: seasonal high water table; poorly drained; silty clay subsoil.	Severe: poorly drained; high shrink-swell potential.	Poor: high shrink-swell potential; poorly drained.
Clarion: 138B, 138C2, 138D2, 138E2.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 14 percent. Severe if slopes are more than 14 percent.	Moderate if slopes are less than 5 percent. Severe if slopes are more than 5 percent.	Slight if slopes are less than 14 percent. Moderate if slopes are more than 14 percent.	Slight if slopes are less than 9 percent. Moderate if slopes are more than 9 percent.	Fair: susceptible to frost action; low strength.

interpretations—Continued

Suitability as source of—continued		Soil features affecting—				
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Unsuitable	Poor: poorly drained silty clay loam.	Moderate permeability; seasonal water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Poorly drained; silty clay loam; seasonal water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent; occasional ponding in places; outlets difficult to determine.	High available water capacity; slopes of 0 to 2 percent; moderate permeability; seasonal water table at a depth of 1 foot to 3 feet.	Slopes of 0 to 2 percent; silty clay loam; moderate permeability; slight depressional positions in uplands.
Good: source of poorly graded sand; unsuited for gravel.	Poor: loamy fine sand; slopes of 4 to 40 percent.	Rapid permeability; slopes of 4 to 40 percent.	Medium shear strength; low to medium compressibility; medium to high permeability of compacted soil; medium to high susceptibility to piping; fair to good compaction characteristics.	Adequate natural drainage.	Low available water capacity; slopes of 4 to 40 percent; rapid permeability; subject to soil blowing and erosion.	Slopes of 4 to 40 percent; subject to soil blowing and erosion; loamy fine sand; hard to vegetate.
Unsuitable	Poor: poorly drained; silty clay loam.	Very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 5 to 14 percent.	Medium to low shear strength; high compressibility; low permeability of compacted soil; and susceptibility to piping; fair to poor compaction characteristics.	Very slow permeability; silty clay and clay subsoil; seasonal high water table at a depth of 1 foot to 3 feet; seepage from upslope; slopes of 5 to 14 percent.	High available water capacity; slopes of 5 to 14 percent; poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; very slow permeability; erosion.	Slopes of 5 to 14 percent; silty clay and clay subsoil; very slow permeability; hard to vegetate.
Unsuitable	Good if slopes are less than 9 percent. Fair if slopes are 9 to 14 percent. Poor if slopes are more than 14 percent.	Moderate permeability; slopes of 2 to 18 percent.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Adequate natural drainage.	High available water capacity; slopes of 5 to 14 percent; moderate permeability; subject to erosion.	Slopes of 2 to 18 percent; subject to erosion; loam; moderate permeability.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
Clinton: 80C2, 80D2, 80E2, 80D3	Moderate if slopes are 5 to 14 percent: moderately slow permeability. Severe if slopes are more than 14 percent.	Moderate if slopes are less than 9 percent. Severe if slopes are more than 9 percent.	Moderate: slopes of 5 to 18 percent; silty clay loam.	Moderate if slopes are less than 14 percent: moderate to high shrink-swell potential; susceptible to frost action. Severe if slopes are more than 14 percent.	Poor: susceptible to frost action; moderate to high shrink-swell potential.
Coland: 135, 135B	Severe: moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; subject to flooding.	Severe: seasonal high water table at a depth of 1 foot to 3 feet; high organic matter content; subject to flooding.	Severe: seasonal high water table at a depth of 1 foot to 3 feet; poorly drained; subject to flooding; silty clay loam.	Severe: poorly drained; subject to flooding; moderate shrink-swell potential.	Poor: moderate shrink-swell potential; poorly drained.
Colo: 133, 133+	Severe: moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; subject to flooding.	Severe: seasonal high water table at a depth of 1 foot to 3 feet; high organic matter content; subject to flooding.	Severe: poorly drained; subject to flooding; seasonal high water table at a depth of 1 foot to 3 feet.	Severe: poorly drained; subject to flooding; high shrink-swell potential; susceptible to frost action.	Poor: moderate shrink-swell potential; poorly drained.
Dickinson: 175B, 175C, 175D	Slight if slopes are 2 to 9 percent. Moderate if slopes are more than 9 percent.	Severe: moderately rapid to rapid permeability.	Severe: moderately rapid to rapid permeability; loamy sand or sand.	Slight if slopes are 2 to 9 percent. Moderate if slopes are more than 9 percent.	Good

interpretations—Continued

Suitability as source of—continued		Soil features affecting—				
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Unsuitable	Fair: slopes of 5 to 14 percent. Poor: slopes of 14 to 18 percent.	Moderately slow permeability; slopes of 4 to 18 percent.	Medium to low shear strength; medium to high compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair compaction characteristics.	Adequate natural drainage.	High available water capacity; slopes of 5 to 18 percent; moderately slow permeability; moderately well drained; subject to erosion.	Slopes of 5 to 18 percent; subject to erosion; silty clay loam subsoil.
Unsuitable in the upper part. Fair in the lower part for sand.	Poor: poorly drained.	Moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; subject to flooding.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderately slow permeability; clay loam; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 5 percent; outlets difficult to establish in places.	High available water capacity; slopes of 0 to 5 percent; seasonal water table at a depth of 1 foot to 3 feet; subject to flooding; moderately slow permeability.	Slopes of 0 to 5 percent; subject to erosion; silty clay loam subsoil.
Unsuitable	Poor: poorly drained; silty clay loam.	Moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; subject to flooding.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent; subject to flooding; outlets difficult to establish.	High available water capacity; slopes of 0 to 2 percent; poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; subject to flooding; moderately slow permeability.	Slopes of 0 to 2 percent; bottom land position.
Good for sand Poor for gravel: too many fines.	Poor: removal of good topsoil exposes loamy sand and sand subsoil; hard to vegetate and control erosion of borrow area.	Moderately rapid to rapid permeability; slopes of 2 to 14 percent.	Medium shear strength; low to medium compressibility; medium to low permeability of compacted soil; medium to high susceptibility to piping; fair to good compaction characteristics.	Adequate natural drainage.	Moderate available water capacity; slopes of 2 to 4 percent; moderately rapid to rapid permeability; subject to erosion and soil blowing.	Slopes of 2 to 14 percent; subject to soil blowing and erosion; fine sandy loam on surface layer grades to loamy sand and sand; difficult to vegetate.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
Downs: 162, 162B, 162C2, 162D2, 162E2, T162B,[1] T162C.[1]	Slight if slopes are 0 to 9 percent. Moderate if slopes are 9 to 14 percent. Severe if slopes are more than 14 percent.	Moderate if slopes are less than 9 percent. Severe if slopes are more than 9 percent.	Slight if slopes are 0 to 14 percent. Moderate if slopes are 14 to 18 percent.	Moderate if slopes are less than 14 percent. Severe if slopes are more than 14 percent: moderate shrink-swell potential; susceptible to frost action.	Fair: moderate shrink-swell potential; susceptible to frost action.
Ely: 428B	Severe: moderate permeability; seasonal high water table.	Moderate: seasonal high water table; high organic matter content.	Severe: seasonal high water table at a depth of 3 to 5 feet; somewhat poorly drained.	Moderate: somewhat poorly drained; moderate shrink-swell potential; susceptible to frost action.	Fair: moderate shrink-swell potential; susceptible to frost action; somewhat poorly drained.
Fayette: 163B, 163C2, 163D2, 163E2, 163F2, 163D3.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 14 percent. Severe if slopes are more than 14 percent.	Moderate if slopes are less than 5 percent: moderate permeability. Severe if slopes are more than 5 percent.	Moderate: silty clay loam; slopes of 2 to 40 percent.	Moderate if slopes are less than 14 percent. Severe if slopes are more than 14 percent; high susceptibility to frost action; moderate shrink-swell potential.	Poor: low strength; slopes of 2 to 40 percent; moderate shrink-swell potential; highly susceptible to frost action.
Flagler: 284B	Slight: danger of ground water contamination.	Severe: moderately rapid to very rapid permeability.	Severe: moderately rapid to very rapid permeability.	Slight	Good

interpretations—Continued

Suitability as source of—continued		Soil features affecting—				
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Unsuitable	Good if slopes are less than 9 percent. Fair if slopes are more than 9 percent.	Moderate permeability; slopes of 0 to 18 percent.	Medium to low shear strength; medium compressibility; medium to low permeability of compacted soil; low to medium susceptibility to piping; fair compaction characteristics.	Adequate natural drainage.	High available water capacity; slopes of 0 to 18 percent; moderate permeability; subject to erosion if slopes are more than 2 percent.	Slopes of 0 to 18 percent; subject to erosion if slopes are more than 2 percent; moderate permeability.
Unsuitable	Fair: silty clay loam; slopes of 2 to 5 percent.	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 2 to 5 percent.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 2 to 5 percent; subject to run-on from upslope.	High available water capacity; slopes of 2 to 5 percent; somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet; subject to run-on from upslope; subject to erosion.	Slopes of 2 to 5 percent; high potential for siltation from run-on water from upslope; foot slope position.
Unsuitable	Good if slopes are less than 9 percent. Fair if slopes are 9 to 14 percent. Poor if slopes are more than 14 percent.	Moderate permeability; slopes of 2 to 40 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Adequate natural drainage.	High available water capacity; slopes of 2 to 40 percent; well drained; subject to erosion.	Slopes of 2 to 40 percent; subject to erosion; silty clay loam subsoil; moderate permeability.
Fair to good for sand; some gravel below a depth of 32 inches.	Good	Moderately rapid to rapid permeability.	Medium to high shear strength; low to medium compressibility; medium to high permeability of compacted soil; medium to high susceptibility to piping; good compaction characteristics.	Adequate natural drainage.	Moderate available water capacity; sand and gravel layer at a depth of about 32 inches; slopes of 1 to 4 percent; subject to soil blowing; very rapid permeability below a depth of 32 inches.	Slopes of 1 to 4 percent; stream terraces on bench position; subject to soil blowing; sandy loam over sand and gravel; moderately rapid to very rapid permeability; hard to vegetate.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
*Gara: 179D2, 179E2, 179F2, 179G, 993D2, 993E2, 993E3. For Armstrong parts of 993D2, 993E2, and 993E3, see Armstrong series.	Severe: moderately slow permeability; slopes of 9 to 40 percent.	Severe: slopes of 9 to 40 percent.	Moderate if slopes are 9 to 14 percent. Severe if slopes are more than 14 percent.	Severe: low strength; slopes of 9 to 40 percent.	Poor: low strength; moderate shrink-swell potential; slopes of 9 to 40 percent.
*Garwin: 118, 117 For Sperry part of 117, see Sperry series.	Severe: moderately slow permeability; seasonal high water table at a depth of 1 foot to 3 feet.	Severe: seasonal high water table at a depth of 1 foot to 3 feet; susceptible to ponding.	Severe: seasonal high water table; poorly drained; silty clay loam.	Severe: poorly drained; low strength; high to moderate shrink-swell potential; high frost action potential.	Poor: low strength; high to moderate shrink-swell potential; poorly drained; highly susceptible to frost action.
Hayden: 168E2, 168F, 168G	Severe: slopes of 14 to 40 percent.	Severe: slopes of 14 to 40 percent.	Moderate if slopes are 14 to 25 percent. Severe if slopes are more than 25 percent.	Severe: low strength; slopes of 14 to 40 percent.	Poor: low strength; moderate shrink-swell potential; slopes of 14 to 40 percent; high susceptibility to frost action.
Judson: 8, 8B, 8C	Moderate: moderate permeability.	Moderate: moderate permeability; slopes of 0 to 5 percent. Severe if slopes are 5 to 9 percent.	Moderate: silty clay loam; receives run-on from upper slopes.	Moderate: moderate shrink-swell potential; low strength.	Poor: low strength; moderate shrink-swell potential.
Kennebec: 212	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; moderate permeability; seasonal high water table; high organic matter content.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; moderate strength; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential; susceptible to frost action.

interpretations—Continued

Suitability as source of—continued		Soil features affecting—				
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Unsuitable	Fair if slopes are 9 to 14 percent. Poor if slopes are more than 14 percent.	Moderately slow permeability; slopes of 9 to 14 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Adequate natural drainage.	High available water capacity; slopes of 9 to 40 percent; moderately well drained to well drained; subject to erosion.	Slopes of 9 to 40 percent; subject to erosion; moderately slow permeability.
Unsuitable	Poor: poorly drained; silty clay loam.	Moderately slow permeability; seasonal water table; slopes of 0 to 2 percent.	Medium to low shear strength; medium to high compressibility; low compacted permeability; low to medium susceptibility to piping; fair compaction characteristics.	Poorly drained; seasonal high water table; slopes of 0 to 2 percent; subject to occasional ponding.	High available water capacity; slopes of 0 to 2 percent; seasonal water table at a depth of 1 foot to 3 feet; poorly drained; moderately slow permeability.	Slopes of 0 to 2 percent; on level upland summits; silty clay loam; moderately slow permeability.
Unsuitable	Poor: slopes of 14 to 40 percent.	Moderate permeability; slopes of 14 to 40 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Adequate natural drainage.	High available water capacity; slopes of 14 to 40 percent; well drained; subject to erosion.	Slopes of 14 to 40 percent; subject to erosion; loam over clay loam; moderate permeability.
Unsuitable	Good	Moderate permeability; slopes of 0 to 9 percent.	Medium to low shear strength; medium compressibility; low compacted permeability; low to medium susceptibility to piping; fair to good compaction characteristics.	Adequate natural drainage.	Slopes of 0 to 9 percent; well drained to moderately well drained; susceptible to run-on from upslope; subject to erosion.	Slopes of 0 to 9 percent; foot slope position; subject to siltation; moderate permeability.
Unsuitable	Good	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent; subject to flooding.	Slopes of 0 to 2 percent; moderately well drained; seasonal high water table at a depth of 3 to 5 feet; subject to flooding.	Slopes of 0 to 2 percent on bottom lands.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
Killduff: 20C2, 20D2, 20E2	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 14 percent. Severe if slopes are 14 to 18 percent.	Severe: slopes of 5 to 18 percent; moderate permeability.	Moderate: silty clay loam.	Severe: low strength; moderate shrink-swell potential; slopes of 5 to 18 percent.	Poor: low strength; moderate shrink-swell potential.
Ladoga: 76B, 76C2, 76D2	Severe: moderately slow permeability; slopes of 2 to 14 percent.	Moderate if slopes are less than 5 percent. Severe if slopes are more than 5 percent.	Moderate: silty clay loam.	Severe: high shrink-swell potential; low strength; slopes of 2 to 14 percent.	Poor: low strength; high shrink-swell potential.
Lamoni: 822D2, 822E2	Severe: slow to very slow permeability; seasonal high water table.	Severe: slopes of 9 to 18 percent; seasonal high water table.	Severe: seasonal high water table; silty clay loam over silty clay; slow to very slow permeability; somewhat poorly drained; slopes of 9 to 18 percent.	Severe: high shrink-swell potential; low strength; slopes of 9 to 18 percent.	Poor: low strength; high shrink-swell potential.
Lawler: 226, 225	Severe: contamination hazard to watercourses nearby; moderate over rapid permeability; substratum somewhat poorly drained; seasonal water table.	Severe: contamination hazard to watercourses nearby; moderate over rapid permeability in the substratum; seasonal high water table.	Severe: contamination hazard to watercourses nearby; seasonal water table; rapid permeability to substratum.	Moderate: somewhat poorly drained; low and very low shrink-swell potential; slopes of 0 to 2 percent.	Fair: somewhat poorly drained; sand and gravel in substratum; low to very low shrink-swell potential; low susceptibility to frost action.

interpretations—Continued

Suitability as source of—continued		Soil features affecting—				
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Unsuitable	Good if slopes are less than 9 percent. Fair if slopes are 9 to 14 percent. Poor if slopes are 14 to 18 percent.	Moderate permeability; slopes of 5 to 18 percent.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderate permeability; slopes of 5 to 18 percent.	Slopes of 5 to 18 percent; moderately well drained; moderate permeability; subject to erosion.	Slopes of 5 to 18 percent; moderately well drained; silty clay loam; moderate permeability.
Unsuitable	Good if slopes are less than 9 percent. Fair if slopes are 9 to 14 percent.	Moderately slow permeability; slopes of 2 to 14 percent.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Adequate natural drainage.	Slopes of 2 to 14 percent; moderately well drained; moderately slow permeability; subject to erosion.	Slopes of 2 to 14 percent; subject to erosion; silty clay loam subsoil at a depth of 11 inches; moderately slow permeability.
Unsuitable	Poor: clay below a depth of 10 inches; slopes of 9 to 18 percent.	Slow to very slow permeability; slopes of 9 to 18 percent.	Medium to low shear strength; high to medium compressibility; low permeability of compacted soil; medium susceptibility to piping; fair to poor compaction characteristics.	Water seeps downslope along slowly to very slowly permeable layer and causes seasonal high water table at a depth of 1 foot to 3 feet; slopes of 9 to 18 percent.	Slopes of 9 to 18 percent; somewhat poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; slow to very slow permeability; subject to erosion.	Slopes of 9 to 18 percent; light and dry below a depth of 10 inches; subject to erosion; slow to very slow permeability; difficult to vegetate.
Good	Good	Moderate over rapid permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent.	Medium shear strength; low to medium compressibility; high to medium permeability of compacted soil; medium to high susceptibility to piping; fair to good compaction characteristics.	Moderate over rapid permeability; seasonal high water table; slopes of 0 to 2 percent; subject to flooding.	Slopes of 0 to 2 percent; somewhat poorly drained; moderate over rapid permeability; seasonal high water table at a depth of 3 to 5 feet.	Slopes of 0 to 2 percent; bottom lands.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
Lester: 236B, 236C2, 236D2	Slight if slopes are 2 to 9 percent: moderate permeability. Moderate if slopes are 9 to 14 percent.	Moderate: moderate permeability; slopes of 2 to 5 percent. Severe if slopes are 5 to 14 percent.	Moderate: loam surface layer; clay loam subsoil and substratum; moderately permeable; slopes of 2 to 14 percent.	Severe: slopes of 2 to 14 percent; moderate shrink-swell potential; high susceptibility to frost action.	Poor: low strength; moderate shrink-swell potential; susceptible to frost action; slopes of 2 to 14 percent.
Lindley: 65E, 65E3, 65F, 65G	Severe: moderately slow permeability; slopes of 14 to 40 percent.	Severe: slopes of 14 to 40 percent.	Severe: slopes of 14 to 40 percent.	Severe: slopes of 14 to 40 percent; moderate shrink-swell potential; high susceptibility to frost action.	Poor: low strength; moderate shrink-swell potential; slopes of 14 to 40 percent.
Mahaska: 280	Severe: moderately slow permeability; seasonal high water table.	Moderate: moderately slow permeability; seasonal high water table.	Severe: seasonal high water table; silty clay loam.	Poor: low strength; moderate shrink-swell potential; susceptible to frost action.	Severe: low strength; moderate shrink-swell potential; susceptible to frost action; somewhat poorly drained.
Marsh: 354	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable
Martinsburg: 742B, 742C	Moderate: moderate permeability.	Moderate if slopes are 2 to 5 percent; moderate permeability. Severe if slopes are 5 to 9 percent.	Moderate: silty clay loam subsoil; receives run-on from upper slopes.	Moderate: moderate shrink-swell potential; low strength.	Fair to poor: low to medium strength; moderate shrink-swell potential; high susceptibility to frost action; slopes of 2 to 9 percent.

interpretations—Continued

Suitability as source of—continued		Soil features affecting—				
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Unsuitable	Good	Moderate permeability; slopes of 2 to 14 percent.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Adequate natural drainage.	Slopes of 2 to 14 percent; well drained; moderate permeability; subject to erosion.	Slopes of 2 to 14 percent; loam to loamy sand; moderate permeability; subject to erosion.
Unsuitable	Poor: slopes of 14 to 40 percent.	Moderately slow permeability; slopes of 14 to 40 percent.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; medium to low susceptibility to piping; fair compaction characteristics.	Adequate natural drainage.	Slopes of 14 to 40 percent; well drained; subject to erosion; moderately slow permeability.	Slopes of 14 to 40 percent; loam to clay loam; moderately slow permeability; subject to erosion.
Unsuitable	Fair: silty clay loam.	Moderately slow permeability; seasonal high water table at a depth of 2 to 4 feet.	Medium to low shear strength; medium compressibility of compacted soil; low to medium susceptibility to piping; fair compaction characteristics.	Moderately slow permeability; seasonal high water table at a depth of 2 to 4 feet.	Slopes of 0 to 2 percent; somewhat poorly drained; moderately slow permeability; seasonal high water table at a depth of 2 to 4 feet.	Slopes of 0 to 2 percent; silty clay loam; on ridgetops.
Unsuitable	Poor: very poorly drained.	Ponded areas	Ponded areas	Ponded areas	Ponded areas	Ponded areas.
Unsuitable	Fair: silty clay loam.	Moderate permeability; slopes of 2 to 9 percent.	Medium to low shear strength; medium compressibility; medium to low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderate permeability; slopes of 2 to 9 percent.	Slopes of 2 to 9 percent; susceptible to overflow from adjacent slopes; well drained to moderately well drained.	Slopes of 2 to 9 percent; subject to erosion on flood slopes position.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
Muscatine: 119	Moderate: moderate permeability; seasonal high water table.	Moderate: moderate permeability; seasonal high water table.	Severe: seasonal high water table; silty clay loam.	Severe: low strength; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential; susceptible to frost action; somewhat poorly drained.
Mystic Mapped only with Caleb soils.	Severe: slow permeability; seasonal high water table.	Severe: slopes of 9 to 18 percent; seasonal high water table.	Severe: seasonal high water table; slopes of 9 to 18 percent; generally clay loam.	Severe: high shrink-swell potential; low strength; slopes of 9 to 18 percent.	Poor: low strength; high shrink-swell potential; somewhat poorly drained.
Nevin: 88	Severe: moderate to moderately slow permeability; seasonal high water table.	Moderate: moderate to moderately slow permeability; seasonal high water table.	Severe: seasonal high water table; silty clay loam.	Severe: low strength; moderate shrink-swell potential; somewhat poorly drained; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential; somewhat poorly drained; susceptible to frost action.
Nicollet: 55	Severe: seasonal high water table at a depth of 3 to 5 feet.	Severe: seasonal high water table at a depth of 3 to 5 feet; moderate permeability.	Severe: seasonal high water table at a depth of 3 to 5 feet; somewhat poorly drained.	Severe: low strength; moderate shrink-swell potential; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential; susceptible to frost action; somewhat poorly drained.
Nira: 570B2, 570C2, 570D2	Severe: moderately slow permeability; slopes of 2 to 14 percent.	Moderate if slopes are less than 5 percent. Severe if slopes are 5 to 14 percent.	Moderate: silty clay loam.	Severe: low strength; moderate shrink-swell potential; slopes of 2 to 14 percent.	Poor: low strength; moderate shrink-swell potential.

interpretations—Continued

Suitability as source of—continued		Soil features affecting—				
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Unsuitable	Fair: silty clay loam.	Moderate permeability; slopes of 0 to 2 percent; seasonal high water table at a depth of 3 to 5 feet.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent.	Slopes of 0 to 2 percent; somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet.	Slopes of 0 to 2 percent on ridgetops.
Unsuitable	Poor: clay loam; slopes of 9 to 18 percent.	Slow permeability; seasonal high water table; underlying material porous in places; slopes of 9 to 18 percent.	Medium to low shear strength; medium compressibility; medium to low permeability of compacted soil; low to medium susceptibility to piping; fair compaction characteristics.	Slow permeability; water seep lines; seasonal high water table; slopes of 9 to 18 percent.	Slopes of 9 to 18 percent; somewhat poorly drained; seasonal high water table; subject to erosion.	Slopes of 9 to 18 percent; clayey subsoil at a depth of 6 inches; difficult to vegetate.
Unsuitable	Fair: silty clay loam.	Moderate to moderately slow permeability; seasonal high water table at a depth of 2 to 4 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderate to moderately slow permeability; seasonal high water table; slopes of 0 to 2 percent.	Slopes of 0 to 2 percent; somewhat poorly drained; seasonal high water table; subject to flooding.	Slopes of 0 to 2 percent on low stream benches.
Unsuitable	Good	Moderate permeability; slopes of 1 to 3 percent; seasonal high water table at a depth of 3 to 5 feet.	Medium to low shear strength; medium compressibility; medium to low permeability of compacted soil; high susceptibility to piping; fair compaction characteristics.	Moderate permeability; slopes of 1 to 3 percent; seasonal high water table at a depth of 3 to 5 feet.	Slopes of 1 to 3 percent; somewhat poorly drained; seasonal high water table at a depth of 3 to 5 feet.	Slopes of 1 to 3 percent.
Unsuitable	Fair: silty clay loam.	Moderately slow permeability; slopes of 2 to 14 percent.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility; fair to good compaction characteristics.	Moderately slow permeability; slopes of 2 to 14 percent; adequate natural drainage.	Slopes of 2 to 14 percent; moderately well drained; subject to erosion.	Slopes of 2 to 14 percent.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
Nodaway: 220	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; moderate permeability; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; susceptible to frost action; moderate shrink-swell potential.	Poor: low strength; moderate shrink-swell potential; susceptible to frost action.
Olmitz: 273B, 273C	Moderate: moderate permeability; slopes of 2 to 9 percent.	Moderate: moderate permeability; slopes of 2 to 9 percent.	Moderate: clay loam surface layer.	Severe: low strength; moderate shrink-swell potential; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential; susceptible to frost action.
Otley: 281B, 281C2, 281D2	Severe: moderately slow permeability; slopes of 2 to 14 percent.	Moderate if slopes are 2 to 5 percent. Severe if slopes are more than 5 percent.	Moderate: silty clay loam.	Severe: high shrink-swell potential; low strength; slopes of 2 to 14 percent.	Poor: low strength; high shrink-swell potential.
Port Byron: 620C2, 620D2, 620E2, 620F2.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 14 percent. Severe if slopes are 14 to 25 percent.	Moderate if slopes are less than 9 percent. Severe if slopes are 9 to 25 percent.	Slight if slopes are less than 14 percent. Moderate if slopes are 14 to 25 percent; probability of sand at depths more than 5 feet.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 14 percent. Severe if slopes are 14 to 25 percent.	Moderate: low shrink-swell potential; susceptible to frost action; slopes of 5 to 25 percent.
*Shelby: 24D2, 24E2, 24F2, 93D2, 93E2. For Adair parts of 93D2 and 93E2, see Adair series.	Severe: moderately slow permeability; slopes of 9 to 25 percent.	Severe: slopes of 9 to 25 percent.	Moderate for area type landfill if slopes are less than 14 percent; severe if more than 14 percent. Moderate if on trench-type landfills: clay loam.	Severe: low strength; slopes of 9 to 25 percent; moderate shrink-swell potential.	Poor: low strength; moderate shrink-swell potential; slopes of 9 to 25 percent.

interpretations—Continued

Suitability as source of—continued		Soil features affecting—				
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Unsuitable	Good	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium compressibility; medium to low permeability of compacted soil; high susceptibility to piping; fair compaction characteristics.	Moderate permeability; seasonal high water table at a depth of 3 to 5 feet; subject to flooding; slopes of 0 to 2 percent.	Slopes of 0 to 2 percent; moderately well drained; seasonal high water table at a depth of 3 to 5 feet; subject to flooding.	Slopes of 0 to 2 percent on bottom land.
Unsuitable	Good: loam; slopes of 2 to 9 percent.	Moderate permeability; slopes of 2 to 9 percent.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Adequate natural drainage; subject to overflow from adjacent side slopes.	Slopes of 2 to 9 percent; well drained to moderately well drained; subject to erosion; receives run-on from adjacent slopes.	Slopes of 2 to 9 percent on foot slopes; subject to siltation.
Unsuitable	Fair: silty clay loam; slopes of 2 to 14 percent.	Moderately slow permeability; slopes of 2 to 14 percent.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderately slow permeability; slopes of 2 to 14 percent.	Slopes of 2 to 14 percent; moderately well drained.	Slopes of 2 to 14 percent; moderately slow permeability; subject to erosion.
Unsuitable	Fair if slopes are 5 to 14 percent. Poor if slopes are 14 to 25 percent.	Moderate permeability; slopes of 5 to 25 percent.	Medium to low shear strength; medium compressibility; medium to low permeability of compacted soil; high susceptibility to piping; fair compaction characteristics.	Adequate natural drainage.	Slopes of 5 to 25 percent; well drained; subject to erosion; moderate permeability.	Slopes of 5 to 25 percent; subject to erosion.
Unsuitable	Fair if slopes are less than 14 percent. Poor if slopes are 14 to 25 percent; clay loam.	Moderately slow permeability; slopes of 9 to 25 percent.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Adequate natural drainage.	Slopes of 9 to 25 percent; moderately well drained; moderately slow permeability; subject to erosion.	Slopes of 9 to 25 percent; subject to erosion; moderately slow permeability.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
Sparta: 41B, 41C2, 41D2	Moderate if slopes are less than 9 percent. Severe if slopes are 9 to 18 percent: hazard of contamination near water courses in places.	Severe: very rapid permeability; slopes of 1 to 18 percent.	Severe: very rapid permeability.	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 18 percent.	Good if slopes are 1 to 14 percent. Fair if slopes are 14 to 18 percent.
Sperry: 122	Severe: slow to very slow permeability; seasonal high water table.	Severe: seasonal high water table	Severe: very poorly drained and poorly drained; seasonal high water table.	Severe: very poorly drained and poorly drained; moderate to high shrink-swell potential; low strength.	Poor: low strength; high shrink-swell potential; very poorly drained and poorly drained.
Storden: 62D, 62E, 62F	Moderate if slopes are 5 to 14 percent. Severe if slopes are 14 to 25 percent.	Severe: slopes of 5 to 25 percent.	Moderate: slopes of 5 to 25 percent.	Moderate if slopes are 5 to 14 percent. Severe if slopes are 14 to 25 percent.	Fair: low strength; slopes of 5 to 25 percent.
Taintor: 279	Severe: slow to moderately slow permeability; seasonal high water table.	Severe: seasonal high water table; susceptible to ponding.	Severe: seasonal high water table; poorly drained; silty clay loam.	Severe: poorly drained; low strength; high shrink-swell potential; susceptible to frost action.	Poor: low strength; high shrink-swell potential; poorly drained; susceptible to frost action.

interpretations—Continued

Suitability as source of—continued		Soil features affecting—				
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Good source of poorly graded fine sand; lacks gravel.	Poor: loamy fine sand; slopes of 1 to 18 percent.	Very rapid permeability; slopes of 1 to 18 percent.	Medium shear strength; low to medium compressibility; medium to low permeability of compacted soil; medium to high susceptibility to piping; fair to good compaction characteristics.	Adequate natural drainage.	Slopes of 1 to 18 percent; excessively drained; permeability is rapid; subject to erosion.	Slopes of 1 to 18 percent; subject to erosion; difficult to vegetate; very rapid permeability.
Unsuitable	Poor: very poorly drained to poorly drained.	Slow to very slow permeability; seasonal high water table at a depth of 0 to 3 feet; slopes of 0 to 2 percent.	Medium to low shear strength; medium compressibility; medium to low permeability of compacted soil; medium to high susceptibility to piping; fair compaction characteristics.	Slow to very slow permeability; seasonal high water table at a depth of 0 to 3 feet; slopes of 0 to 1 percent; outlets not readily available; ponding occurs after heavy rains.	Slopes of 0 to 1 percent; poorly drained to very poorly drained; seasonal high water table at a depth of 0 to 3 feet; slow to very slow permeability.	Slopes of 0 to 1 percent on upland positions.
Unsuitable	Moderate if slopes are 5 to 14 percent. Severe if slopes are 14 to 25 percent.	Moderate permeability; slopes of 5 to 25 percent.	Medium to low shear strength; medium compressibility; medium to low permeability of compacted soil; medium to high susceptibility to piping; fair compaction characteristics.	Adequate natural drainage.	Slopes of 5 to 25 percent; somewhat excessively drained; moderate permeability; subject to erosion.	Slopes of 5 to 25 percent on upland side slopes; subject to erosion; difficult to vegetate.
Unsuitable	Poor: poorly drained; silty clay loam.	Slow to moderately slow permeability; seasonal high water table; slopes of 0 to 2 percent.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair compaction characteristics.	Moderately slow to slow permeability; seasonal high water table; slopes of 0 to 2 percent; some ponding occurs after heavy rains.	Slopes of 0 to 2 percent; poorly drained; moderately slow to slow permeability; seasonal high water table at a depth of 1 foot to 3 feet.	Slopes of 0 to 2 percent on upland flat divides; slow to moderately slow permeability.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
Tama: 120, 120B, 120C2, 120D2, T120B,[1] T120C.[1]	Slight if slopes are less than 9 percent. Moderate if slopes are 9 to 14 percent.	Moderate if slopes are less than 5 percent; moderate permeability. Severe if slopes are 5 to 14 percent.	Moderate: silty clay loam.	Severe: low strength; moderate shrink-swell potential; slopes of 0 to 14 percent.	Poor: low strength; moderate shrink-swell potential.
Terril: 27B	Slight	Moderate: moderate permeability; slopes of 2 to 5 percent.	Slight	Moderate: low strength; susceptible to frost action.	Fair: low strength; susceptible to frost action.
Tuskeego: 453	Severe: subject to flooding; very slow permeability; seasonal high water table.	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding; seasonal high water table; silty clay; hazard of contamination near watercourse.	Severe: very poorly drained; high to moderate shrink-swell potential; subject to flooding; low strength.	Poor: low strength; high to moderate shrink-swell potential; poorly drained.
Wabash: 172	Severe: seasonal high water table; subject to flooding; very slow permeability.	Severe: seasonal high water table; subject to flooding; high organic matter content.	Severe: subject to flooding; very poorly drained; seasonal high water table; silty clay.	Severe: very poorly drained; subject to flooding; low strength; high shrink-swell potential.	Poor: low strength; high shrink-swell potential; very poorly drained.

interpretations—Continued

Suitability as source of—continued		Soil features affecting—				
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Generally unsuitable: exploration needed on benches; possibility of sand below a depth of 5 feet.	Fair: slopes of 0 to 14 percent; silty clay loam.	Moderate permeability; slopes of 0 to 14 percent.	Medium to low shear strength; medium compressibility; medium to low permeability of compacted soil; medium to high susceptibility to piping; fair compaction characteristics.	Adequate natural drainage.	Slopes of 0 to 14 percent; well drained; moderate permeability; subject to erosion on slopes of more than 2 percent.	Slopes of 0 to 14 percent; subject to erosion on slopes of more than 2 percent; moderate permeability.
Unsuitable	Good	Moderate permeability; slopes of 2 to 5 percent.	Medium to low shear strength; medium compressibility; medium to low permeability of compacted soil; medium to high susceptibility to piping; fair compaction characteristics.	Adequate natural drainage.	Slopes of 2 to 5 percent; moderately well drained; moderate permeability.	Slopes of 2 to 5 percent on foot slope position; moderate permeability.
Unsuitable	Poor: poorly drained.	Very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 1 percent; subject to flooding and ponding.	Medium to low shear strength; medium compressibility; medium to low permeability of compacted soil; high to medium susceptibility to piping; fair compaction characteristics.	Very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; subject to flooding and ponding; slopes of 0 to 1 percent.	Slopes of 0 to 1 percent; very slow permeability; poorly drained; subject to flooding; seasonal high water table at a depth of 1 foot to 3 feet.	Slopes of 0 to 1 percent on bottom lands; very slow permeability; difficult to outlets.
Unsuitable	Poor: very poorly drained; silty clay.	Very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent; subject to flooding and ponding.	Medium to low shear strength; high compressibility; low permeability of compacted soil; low susceptibility to piping; fair to poor compaction characteristics.	Very slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent; subject to flooding and ponding.	Slopes of 0 to 2 percent; very slow permeability; very poorly drained; susceptible to stream overflow; seasonal high water table at a depth of 1 foot to 3 feet.	Slopes of 0 to 2 percent on bottom lands; silty clay; very slow permeability.

TABLE 7.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—				Suitability as source of—
	Septic tank absorption fields	Sewage lagoons	Sanitary landfill	Local roads and streets	Road fill
Webster: 107	Severe: seasonal high water table; moderate to moderately slow permeability.	Severe: seasonal high water table; moderate to moderately slow permeability; moderate organic matter content.	Severe: poorly drained; silty clay loam.	Severe: poorly drained; low strength; moderate shrink-swell potential; susceptible to frost action.	Poor: low strength; shrink-swell potential; poorly drained.
Wiota: 7	Slight	Severe: moderate permeability; hazard of contamination; possibility of sand below a depth of 5 feet; near water course.	Severe: silty clay loam; hazard of contamination; possibility of sand below a depth of 5 feet; near water course.	Severe: low strength; moderate shrink-swell potential; susceptible to frost action.	Poor: low strength; moderate shrink-swell potential.
Zook: 54	Severe: subject to flooding; slow permeability; seasonal high water table.	Severe: subject to flooding; seasonal high water table; high content of organic matter.	Severe: subject to flooding; poorly drained; seasonal high water table; hazard of contamination.	Severe: poorly drained; subject to flooding; high shrink-swell potential; susceptible to frost action.	Poor: low strength; high shrink-swell potential; poorly drained; susceptible to frost action.

[1] Bench phases, indicated by a "T" prefix, generally are underlain by stratified alluvium instead of glacial till. Alluvium is

gray, deoxidized colors and by mottles, concretions, and pipestems produced by segregations of iron. The Nira and Killduff soils, for instance, formed at least partly in the weathered loess.

Glacial till is a major parent material of the soils on uplands. It is a heterogeneous mixture of sand, silt, clay, pebbles, and boulders deposited by glaciers. It shows little or no evidence of sorting by water. Three glaciers deposited material in Jasper County. The Nebraskan till was buried by the Kansan till and normally is exposed only near the base of the steeper slopes (*4*). The two tills are similar. They are separated by a paleosol that formed in the upper part of the Nebraskan till before it was buried. These two tills, where unweathered, are calcareous, firm clay loam. Soils that formed in this parent material include the Shelby, Gara, and Lindley soils.

During interglacial times, soils formed in the till that was exposed at the surface. These interglacial periods were the Aftonian, after the Nebraskan; the Yarmouth, after the Kansan; and the Sangamon, after the Illinoian glacial period (the Illinoian glacier did not extend into Jasper County). Subsequently, these paleosols were covered by glacial till or loess, or both. They have been beveled and exposed by geological erosion and today crop out on hillsides. Soils that formed on stable positions during the Aftonian and the Yarmouth-Sangamon interglacial periods were strongly weathered and the paleosol that developed had a thick, gray, clayey subsoil. It is called gumbotil (*3*). The Clarinda soils formed mainly in the exposed gumbotil. The Lamoni soils formed where the upper part of the gumbotil has been eroded away. They formed in the lower part and have a thinner clayey layer than Clarinda soils.

Some surfaces continued to erode and did not stabi-

interpretations—Continued

Suitability as source of—continued		Soil features affecting—				
Sand and gravel	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage for crops and pasture	Irrigation	Terraces and diversions
Unsuitable	Poor: poorly drained.	Moderate to moderately slow permeability; slopes of 0 to 2 percent; subject to ponding.	Medium to low shear strength; medium compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair to good compaction characteristics.	Moderate to moderately slow permeability; slopes of 0 to 2 percent; subject to ponding.	Slopes of 0 to 2 percent; moderate to moderately slow permeability; poorly drained.	Slopes of 0 to 2 percent; moderate to moderately slow permeability; silty clay loam.
Generally unsuitable; sand occurs below a depth of 5 feet; exploration needed.	Good	Moderate permeability; slopes of 0 to 2 percent.	Medium to low shear strength; medium to high compressibility; low permeability of compacted soil; low to medium susceptibility to piping; fair compaction characteristics.	Adequate natural drainage.	Slopes of 0 to 2 percent; moderate.	Slopes of 0 to 2 percent on stream benches; silty clay loam; moderate permeability.
Unsuitable	Poor: poorly drained.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent; subject to flooding.	Medium to low shear strength; medium to high compressibility; low permeability of compacted soil; low susceptibility to piping; fair compaction characteristics.	Slow permeability; seasonal high water table at a depth of 1 foot to 3 feet; slopes of 0 to 2 percent; subject to flooding.	Slopes of 0 to 2 percent; slow permeability; poorly drained; seasonal high water table at a depth of 1 foot to 3 feet; susceptible to stream overflow.	Slopes of 0 to 2 percent on bottom lands; silty clay loam to silty clay; slow permeability.

coarse textured and at a depth of as little as 5 feet in places.

lize until Sangamon times. Paleosols formed on these sloping surfaces during the late Sangamon interglacial period. Those paleosols are less weathered than the gumbotil. They are reddish and are thinner and less clayey than the gumbotil. They are characterized by a stone line in the upper part of the clayey layer or immediately over that layer. On the stone line is an overburden of loamy sediments (*7, 9*). This late Sangamon paleosol is in the parent material for Adair and Armstrong soils (fig. 18).

The third glaciation, the Carey substage of the Wisconsin, covered approximately one township in the northwest corner of the county. This glaciation occurred about 12,000 to 14,000 years ago, after the period of loess deposition (*8*). Where unweathered, the till is calcareous, friable loam. Soils that formed in this parent material include the Clarion, Hayden, and Lester soils. Water has moved some soil material from the higher elevations to lower positions nearby. The Webster, Canisteo, and Nicollet soils formed in these sediments and in the underlying till.

Alluvium is the parent material of most of the soils in the valleys. It is material deposited by water, and it ranges from silty clay or clay to sand in texture. Some alluvium has been deposited within the past few years. Much of the alluvium on stream benches and second bottom lands, however, was deposited many years ago. Some of the benches are underlain by coarse textured glacial outwash, which is sand and gravel washed from melting glaciers and deposited in the valleys by water.

The recent alluvium is so mixed in places that no soil series is identified. These areas are shown on the map as Alluvial land. Soils that formed in recent alluvium include Nodaway and Ackmore soils. These soils are lighter colored and more stratified in color and texture than soils in older alluvium.

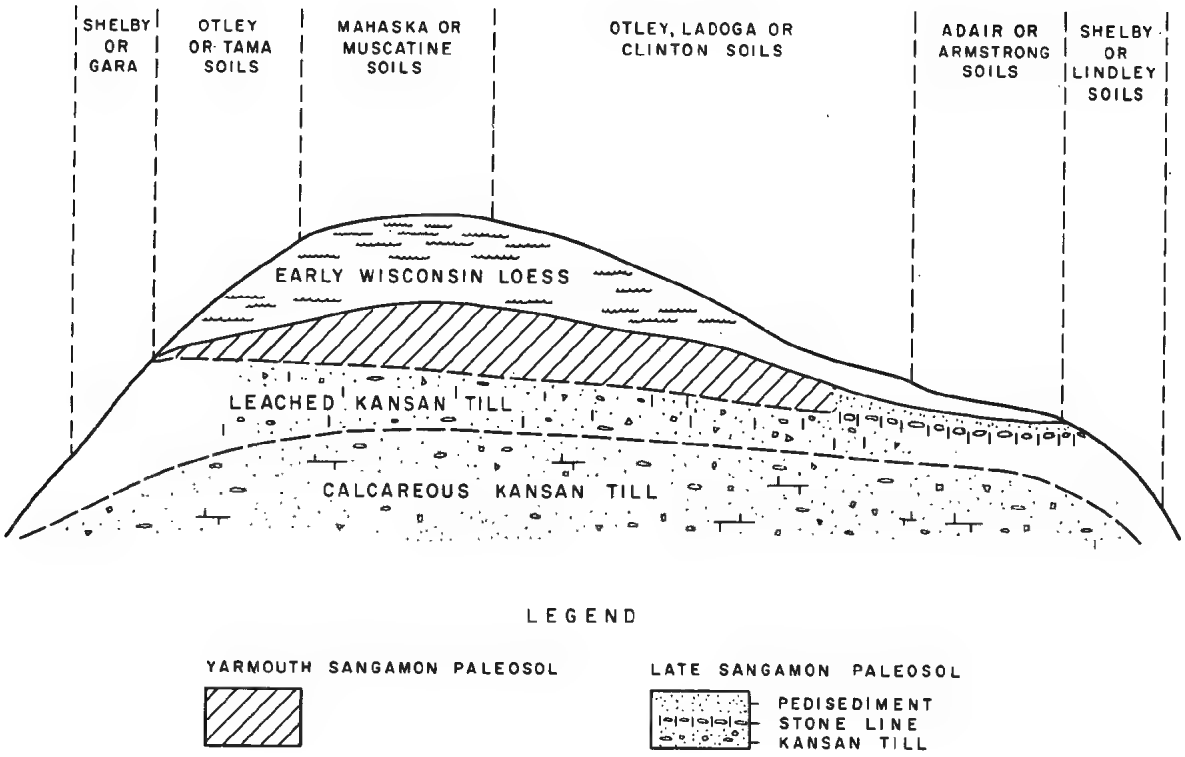

***Figure 17.*—Relationship of parent material to some soils of Jasper County.**

Generally, the Coland, Colo, Kennebec, Wabash, and Zook soils formed in older alluvium than Nodaway and Ackmore soils. They have accumulated more organic matter, so they are darker colored. They are also less stratified. This results partly from being farther from the stream in positions where particles dropped by the floodwaters are more uniform in size. It also results from the greater length of time that soil forming processes have influenced the mixing of the different layers of alluvium.

Lawler soils are on benches. These soils formed in older alluvium that overlies glacial outwash. Wiota and Nevin soils also are on benches.

A number of soils formed in local alluvium. This alluvium washed from nearby hillsides and is on alluvial fans and foot slopes. The local alluvium is also called colluvium. The Ely, Judson, Martinsburg, Olmitz, and Terril soils formed in local alluvium.

Caleb and Mystic soils formed in very old alluvium. This alluvium was derived from the erosion of glacial till during geologic times. It exists now mainly as remnants of high benches or foot slopes along the edges of the larger valleys.

Eolian sand is a minor parent material in Jasper County. It is a wind deposited material that has a high content of fine and very fine sand. Most of the eolian sand is on stream benches or on the uplands near major streams. Some of the sand on the benches was deposited originally by water and then reworked by wind. Sparta and Chelsea soils formed in this parent material.

Bedrock is buried to a considerable depth by glacial till and loess in most places. Bauer soils formed in shale. Narrow outcrops of sandstone occur in a few places. They are indicated by a special symbol on the soil map and are not identified by soil series.

Climate

Available evidence suggests that in Jasper County the soils have been developing under the influence of a midcontinental, subhumid climate for at least 5,000 years. Between 5,000 and 16,000 years ago, the climate was conducive to forest vegetation (*7*). The morphology of most soils of Jasper County indicates that the soils developed in a climate similar to the present climate.

The average precipitation is 33 inches. May and June have the most precipitation and February has the least. The average length of growing season is 165 days. The annual daily maximum temperature is 60.6° F and the daily minimum temperature is 39.4° F. The warmest month is July and the coldest month is January. The average amount of snowfall in the county is about 33 inches.

The influence of the general climate of the region is modified by local conditions in or near the developing soil. The climate in south-facing areas is warmer and less humid than the climate in level or north-facing

Figure 18.—**A paleosol underlying loess in a road cut. Where this paleosol is exposed on hillsides, it is the parent material for Adair and Armstrong soils.**

areas. The bottom lands are wetter and colder than most areas around them. These contrasts account for some differences in soils within the same general climatic region.

Plant and animal life

A number of kinds of living organisms are important in soil development. The activities of burrowing animals, worms, and micro-organisms are reflected in soil properties. Differences in the kind of vegetation cause the most marked differences between soils (*5*).

Tall grasses were luxuriant in the open parts of the landscape. Forests were along the rivers and larger creeks.

Soils that formed under prairie vegetation typically have a thicker, darker colored surface layer than soils that formed under trees, because grasses have many roots and tops that have decayed or are in the soil. The organic matter under trees was derived principally from leaves. It was deposited mainly on the surface of the soil. Soils that formed under trees generally are more acid than those that formed under grass. Tama and Otley soils are typical of those that formed under prairie vegetation. Soils such as Fayette and Clinton soils formed under trees. Gara and Downs soils have properties that are intermediate between properties of soils that formed under trees and those that formed under grass.

Man has had marked influence on soils. Changes have occurred in the soil as a result of use. Changes caused by water erosion are the most apparent. On many cultivated soils part of the original surface layer has been lost through sheet erosion. In some places all the original surface layer is gone and gullies have formed. Tillage alters the structure of the surface layer of the soil; in many places a compacted plow sole is evident. Less obvious are chemical changes brought about by lime and fertilizer and changes in microbial activity and organic matter content that result from removing the native vegetation and substituting crops.

Relief

Relief, or topography, refers to the lay of the land. It ranges from nearly level to very steep in Jasper County. Relief is an important factor in soil formation because of its effect on drainage, runoff, height of water table, and erosion. Differences in topography is the basic reason for the differing properties of some of the soils in the county.

Even though soils formed in the same parent material, the influence of relief is seen in the color, thickness, and horizonation of the soils. Tama, Muscatine, and Garwin soils are examples of soils that formed in similar parent material but differ in characteristics mainly because of relief. Garwin soils are poorly drained and occur on level, slightly concave uplands where surface runoff is slow or impounded. Muscatine soils are somewhat poorly drained and are on nearly level uplands. Some of the water runs off. Tama soils are well drained and in positions where much water runs off and erosion occurs. The water percolates through soils and removes clay from the A horizon. Much of this clay accumulates in the B horizon. Garwin soils have accumulated more clay than Tama soils. Muscatine soils have a thicker surface layer than Tama soils. The steeper the slopes, the less thick the dark colored surface layer in Tama soils.

Relief affects the color of the B horizon through its effect on drainage and aeration. The subsoil of a soil with good drainage generally is brown because iron compounds are oxidized and distributed throughout the horizon. Tama is an example of a soil that has a brownish subsoil. The subsoil of a soil with restricted drainage is generally grayish or mottled in color. Garwin soils have grayish colors in the subsoil. The Zook soils of the bottom lands have a grayish colored or mottled gray subsoil and they are poorly drained.

Time

The passage of time enables the factors of relief, climate, and plant and animal life to bring about changes in parent material. Very similar soils form in widely different kinds of parent material if other factors continue to be active over long periods of time. Soil development, however, is generally interrupted by geologic events that expose new material.

New parent material has been added to the uplands at least three times (*13*). In most of the county the bedrock has been covered by glacial drift from two different glaciers. Then the present surface material, the loess, was deposited. In the northwest corner another material was added by a more recent glacier about 12,000 to 14,000 years ago. Each time new material has been added, existing soils were buried and further development in them stopped (*6*). In places the paleosols have been uncovered by erosion. These old soils became the parent material for soils forming under climatic conditions that have existed since that material was reexposed at the surface. Adair, Armstrong, Clarinda, and Lamoni soils are present-day

soils that formed in paleosols in the Kansan or Nebraskan tills.

The radiocarbon technique for determining the age of carbonaceous material found in loess and till has been useful in dating soils of Wisconsin age (*8*). Loess deposition took place about 29,000 to 14,000 years ago (*7*).

Geologic erosion, however, has beveled much of the landscape, removed material from side slopes, and deposited new sediments downslope (*10*). The soils on the side slopes are generally less than 14,000 years old. The soils that formed on foot slopes, such as Ely soils, are more recent, and some are less than 1,800 years old.

Processes of soil horizon differentiation

A soil is composed of one or more layers called horizons. Soil horizons approximately parallel the land surface and are differentiated on the basis of properties such as color, texture, structure, thickness, and mineral and chemical composition. The horizons of a soil occur in a vertical sequence from the surface down to a depth of several feet. The sequence of horizons collectively makes up a soil profile. Each soil has a unique profile that varies in the kind and number of horizons.

Horizon differentiation occurs because of four basic kinds of change. These are additions, removals, transfers, and transformations in the soil system (*11*). Each of these four kinds of change affects many substances that make up soil. For example, there are additions, removals, transfers, or transformations of organic matter, soluble salts, carbonates, sesquioxides, or silicate clay minerals.

In general these processes tend to promote horizon differentiation, but some tend to offset or retard it. These processes, and the changes brought about, proceed simultaneously in soils, and the ultimate nature of the profile is governed by the balance of these changes within the profile.

All soils in Jasper County have some accumulation of organic matter in the uppermost part of the profile. These soils range from high to very low in organic matter content. For example Fayette, Clinton, and Chelsea soils have a thin A1 horizon and are low or very low in organic matter content, whereas Garwin and Colo soils have a thick A1 horizon and are high in organic matter content.

The removal of substances from parts of the profile is important in the differentiation of soil horizons in Jasper County. The movement of calcium carbonates downward in the soil material as a result of leaching is an example. In Storden soils, for example, little calcium carbonate has been removed, so they are calcareous at or near the surface. Most soils in Jasper County, however, are moderately to strongly leached. Adair, Clinton, and Lindley soils have a strongly leached profile.

The translocation of clay minerals is an important process in horizon differentiation. The clay minerals are carried downward from the A horizon in suspension in percolating water. They accumulate in the B horizon in pores and root channels and as clay films on ped faces. Clinton and Fayette soils are good examples of soils in which clay minerals have been translocated downward to the B horizon.

Another kind of transfer, which is minimal in most soils of this county, occurs by shrinking and swelling. In very clayey soils cracks form and some materials from the surface layer are incorporated into lower parts of the profile. Clarinda, Zook, and Wabash soils have a high potential for this type of transfer.

Transformations are both physical and chemical. For example, soil particles are weathered to smaller sizes. Gleying, a chemical process, involves the saturation of soil with water for long periods of time in the presence of organic matter. It is characterized by the presence of ferrous iron and by neutral gray colors that commonly change to brown on exposure to air. Gleying is associated with poorly drained and very poorly drained soils such as Garwin and Wabash soils.

Classification of the soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965 (*12*). Because this system is under continual study, readers interested in developments of the current system should search the latest literature available (*15*).

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. The same property or subdivisions of this property may be used in several different categories. In table 8, the soil series of Jasper County are placed in three categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER.—Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. Three exceptions to this are the Entisols, Histosols, and Vertisols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Moll-i-sol). Four of the ten orders—Alfisols, Entisols, Inceptisols, and Mollisols—are represented in Jasper County.

SUBORDER.—Each order is divided into suborders

using those characteristics that seem to produce classes with the greatest genetic similarity. The suborders are more narrowly defined than are the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of a water table at a shallow depth, soil climate, the accumulation of clay, iron, or organic carbon in the upper part of the solum, cracking of soils caused by a decrease in soil moisture, and fine stratification. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquoll* (Aqu, meaning water or wet, and *oll,* from Mollisol).

GREAT GROUPS.—Soil suborders are divided into great groups on the basis of uniformity in the kinds and sequence of soil horizons and features. The horizons used to make separations are those in which clay, carbonates, and other constituents have accumulated or have been removed; and those that have pans that interfere with growth of roots, movement of water, or both. Some features used are reaction, soil climate, soil composition, and color. The names of great groups have three of four syllables and are made by adding a prefix to the name of the suborder. An example is Haplaquoll (*Hapl,* meaning simple horizons, *aqu* for wetness or water, and *oll,* from Mollisols).

SUBGROUPS.—Great groups are divided into subgroups, one representing the central (typic) segment of the group, and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Other subgroups may have soil properties unlike those of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Haplaquolls (a typical Haplaquoll).

FAMILIES.—Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, soil depth, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on that are used as family differentiae. (See table 8.) An example is the fine-loamy, mixed, mesic family of Typic Haplaquolls.

Environmental factors affecting soil use

Certain factors that affect or have affected the use of soils are discussed in this section. This information was compiled from records of the U.S. Bureau of the Census, the National Weather Service, and other published sources.

History and development

About 1843 the first settlers arrived in what is now Jasper County and settled near Monroe. Jasper County was organized in 1846. Before 1846, this area was the hunting ground of Indians of the Iowa, Sac, and Fox tribes.

Most of the early settlers were from states east of Iowa. Some settlers came from as far away as New England. Some parts of the county were settled by immigrants from Germany and Holland.

In 1920 the total population of Jasper County was 27,855. Newton, the county seat, had a population of 6,627. In 1970 Newton's population was 15,619 and Jasper County's was 35,424. Eleven other towns or villages had populations totaling more than 8,000.

Transportation

Federal, State, and County roads provide routes for auto traffic and for transporting farm products to market. Interstate 80 extends east and west across the middle of Jasper County. Railroad tracks cross the county from east to west and from north to south, and the trains serve many of the towns in the county. Bus transportation is available in many parts of the county, and motor freight lines serve most of the trading centers. Surfaced roads are on most section lines.

Marketing

Farm products can be sold at many outlets in the county. Livestock sale pavillions, buying stations, and grain elevators are available in the major towns. Farm centers and implement dealers are available. Communication also helps to make agriculture a thriving enterprise in Jasper County. Specialization in both crop and livestock programs is increasing. Production of hybrid corn seed is a growing industry. A bull testing station near Newton is also a promising enterprise. Most milk produced in the county is marketed at adequate outlets such as the large creameries in Des Moines and a cheese plant in Newton.

Topography

Jasper County is in the central part of the State. Nearly level to hilly, loess-covered uplands extend over the major part of it. The northwest corner of the county is a nearly level to rolling glacial till plain.

Drainage is mainly via the South Skunk River and its tributaries. The North Skunk River is second in size to the South Skunk River. It drains the north-central and eastern parts of the county and joins the South Skunk River in Keokuk County. Indian Creek is the largest tributary of the South Skunk River. It enters the county near the northwest corner. Squaw Creek and Buck Creek are the other principal tributaries. Drainage courses in the county run mainly southeast. Small tributaries of the Iowa River drain the northeast corner of the county. The southwest corner is drained by tributaries of the Des Moines River.

The uplands in the county are approximately 900 feet to 1,000 feet above sea level. The highest town in the county is Newburg, where the elevation is 1,029 feet above sea level. The lowest elevation, about 750 feet above sea level, is on the South Skunk River bottom, south of Reasnor.

TABLE 8.—*Soil classification*

Series	Family	Subgroup	Order
Ackmore	Fine-silty, mixed, nonacid, mesic	Aeric Fluvaquents	Entisols.
Adair [1]	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Armstrong	Fine, montmorillonitic, mesic	Aquillic Hapludalfs	Alfisols.
Atterberry	Fine-silty, mixed, mesic	Udollic Orchraqualfs	Alfisols.
Bauer [1]	Fine, mixed, mesic	Typic Hapludolls	Mollisols.
Bolan	Coarse-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Bremer [1]	Fine, montmorillonitic, mesic	Typic Argiaquolls	Mollisols.
Caleb	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Canisteo	Fine-loamy, mixed (calcareous), mesic	Typic Haplaquolls	Mollisols.
Chelsea	Mixed, mesic	Alfic Udipsamments	Entisols.
Clarinda [1]	Fine, montmorillonitic, mesic, sloping	Typic Argiaquolls	Mollisols.
Clarion	Fine-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Clinton	Fine, montmorillonitic, mesic	Typic Hapludalfs	Alfisols.
Coland [1]	Fine-loamy, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Colo	Fine-silty, mixed, mesic	Cumulic Haplaquolls	Mollisols.
Dickinson	Coarse-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Downs	Fine-silty, mixed, mesic	Mollic Hapludalfs	Alfisols.
Ely	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Fayette	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.
Flagler [1]	Coarse-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Gara	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Garwin	Fine-silty, mixed, mesic	Typic Haplaquolls	Mollisols.
Hayden	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Judson	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Kennebec	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Killduff	Fine-silty, mixed, mesic	Dystric Eutrochrepts	Inceptisols.
Ladoga	Fine, montmorillonitic, mesic	Mollic Hapludalfs	Alfisols.
Lamoni [1]	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Lawler	Fine-loamy over sandy or sandy-skeletal, mixed, mesic.	Aquic Hapludolls	Mollisols.
Lester [1]	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Lindley	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Mahaska	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Martinsburg	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.
Muscatine	Fine-silty, mixed, mesic	Aquic Hapludolls	Mollisols.
Mystic [1]	Fine, montmorillonitic, mesic	Aquollic Hapludalfs	Alfisols.
Nevin [1]	Fine-silty, mixed, mesic	Aquic Argiudolls	Mollisols.
Nicollet	Fine-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Nira [1]	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Nodaway	Fine-silty, mixed, nonacid, mesic	Mollic Udifluvents	Entisols.
Olmitz	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Otley	Fine, montmorillonitic, mesic	Typic Argiudolls	Mollisols.
Port Byron	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Shelby	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Sparta	Sandy, mixed, mesic	Entic Hapludolls	Mollisols.
Sperry	Fine, montmorillonitic, mesic	Typic Argialbolls	Mollisols.
Storden	Fine-loamy, mixed (calcareous), mesic	Typic Udorthents	Entisols.
Taintor	Fine, montmorillonitic, mesic	Typic Argiaquolls	Mollisols.
Tama	Fine-silty, mixed, mesic	Typic Argiudolls	Mollisols.
Terril	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Tuskeego	Fine, montmorillonitic, mesic	Mollic Ochraqualfs	Alfisols.
Wabash	Fine, montmorillonitic, mesic	Vertic Haplaquolls	Mollisols.
Webster	Fine-loamy, mixed, mesic	Typic Haplaquolls	Mollisols.
Wiota	Fine-silty, mixed, mesic	Typic Argiudolls	Mollisols.
Zook	Fine, montmorillonitic, mesic	Cumulic Haplaquolls	Mollisols.

[1] All or part of the mapping units are taxadjuncts to the series. Reasons are discussed in the series descriptions.

Climate [5]

Climate for Jasper County is represented by data taken at Newton in Jasper County and at Grinnell in Poweshiek County. Temperature and precipitation are given in table 9, and probabilities of freezing temperatures in spring and fall are given in table 10.

Average annual precipitation is about 33 inches. June is the wettest month, followed by May, July, and August. During the 1951–60 period, an average of 21 days per year had 0.50 inch of precipitation or more, and 58 days had 0.10 inch or more. About 75 percent of the warm season rainfall occurs as showers, some heavy enough to cause serious erosion. The intensity and duration of showers vary widely across the county. The probability of receiving an inch of rainfall or more in one week is about 4 years in 10 in June and 2 or 3 years in 10 in July and August.

Temperatures at Newton, particularly maximum temperatures, are representative of the county. There is a small temperature gradient from north to south across the county. At Newton, an average of 32 days

[5] This section was prepared by ROBERT J. SHAW, climatologist, Iowa State University.

TABLE 9.—*Temperature and precipitation*

[All data from Newton]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average highest	Average lowest	Average total	One year in 10 will have—		Days with snow cover 1.0 inch or more	Average depth of snow on days with snow cover
						Less than—	More than—		
	°F	°F	°F	°F	In	In	In		In
January	30	13	51	−14	1.4	0.2	2.9	20	5
February	35	16	53	−6	1.1	.1	2.4	16	5
March	45	26	70	5	2.3	.8	4.8	10	6
April	61	39	83	24	2.8	1.2	5.3	(1)	2
May	73	51	88	35	4.1	1.5	7.5		
June	82	61	93	46	4.9	1.9	10.9		
July	88	65	97	53	3.8	1.1	6.7		
August	86	63	96	50	3.7	1.0	6.2		
September	78	54	91	37	3.3	.8	7.9		
October	67	43	84	26	2.2	.2	4.6	(1)	2
November	48	29	70	10	2.1	.2	3.9	3	3
December	35	18	56	−5	1.3	.5	2.4	11	4
Year	61	40	[2] 98	[3] −15	33.0	23.6	42.8	60	5

[1] Less than ½ day.
[2] Average annual highest temperature.
[3] Average annual lowest temperature.

per year have maximum temperatures equal to or greater than 90° F. These temperatures are too high for optimum crop production. Minimum temperatures tend to vary more across the county. Areas that are in low positions relative to the surrounding areas have lower minimum temperatures on a calm, clear night than urban or upland areas.

The average date of the last killing frost in spring at Grinnell is April 30, and the first in fall is October 12. These dates are representative for Jasper County. The average growing season is 164 days.

For good crop production, both adequate warm-season rainfall and adequate subsoil-moisture reserves are needed. The average moisture in the soil is between 8 and 9 inches on April 15th, and the chance of having less than 5 inches at this time is less than 10 percent. An adequate reserve of moisture in the soil is 7 to 8 inches, and 5 inches or less is considered low. In years that have low moisture reserve, more than normal warm-season rainfall is needed if average crop yields are to be obtained.

Trends in farming

Farming in Jasper County is discussed in this section. Unless otherwise stated, the data given are from the 1972 Iowa annual farm census, published by the Iowa Department of Agriculture, Division of Agriculture Statistics.

Farming is the main enterprise in Jasper County, and it is diversified. It includes both crop production and raising of livestock. About 94 percent, or 441,179 acres, of the county is in farms. The average size of the farms is 247 acres. In 1972 only 44 percent of the farms were farmed by owners; the rest were operated by tenants. The trend for a number of years has indicated a decrease in the farm population and the number of farms, and an increase in the average size of farms.

Corn is the major crop. Most of the corn is used as feed for livestock on the farm. The rest is sold. Other crops grown include soybeans, oats, hay, sorghum, barley, and wheat. The acreage in sorghum, barley, and wheat is very small. Oats and hay are mainly grown in rotation with corn and soybeans. Hay crops are primarily mixtures of alfalfa and grasses.

In recent years, the acreage in corn has decreased slightly and the acreage in soybeans has greatly increased. The acreage in oats and hay has also decreased.

Yields have been steadily increasing because of increased use of fertilizer and lime, more productive facilities, better erosion control, and improved management. The acreage of crops in Jasper County in 1972 was as follows: corn, 145,315; soybeans, 70,796; oats, 18,050; all hay, 33,696; all pasture, 98,337.

Feeding beef cattle and hogs is the most important livestock enterprise. Many of the beef cattle are brought from out of the State and trucked into the county for feeding. Hogs are mostly farrowed and fed on the same farm, but some feeder pigs are brought in.

The number of beef cattle, hogs, and lambs that are fed in the county is increasing. Dairy cows and heifers on hand are decreasing, but beef cows and heifers on hand are increasing. The production of chickens has also decreased.

The numbers of the principal kinds of livestock raised or sold or on hand in 1972 were as follows:

TABLE 10.—*Probabilities of last freezing temperatures in spring and first in fall*

[All data from Grinnell, Poweshiek County]

Probability	Dates for given probability and temperature				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than	April 3	April 22	April 26	May 6	May 15
2 years in 10 later than	March 28	April 16	April 21	May 1	May 10
5 years in 10 later than	March 18	April 5	April 10	April 21	April 30
Fall:					
1 year in 10 earlier than	October 30	October 20	October 13	October 3	September 27
2 years in 10 earlier than	November 4	October 25	October 19	October 8	October 2
5 years in 10 earlier than	November 15	November 5	October 30	October 19	October 12

grain-fed cattle marketed, 43,632; hogs marketed, 268,830; grain-fed sheep and lambs marketed, 3,255; milk cows, 4,302; beef cows, 24,110; hens and pullets of laying age, 58,363; commercial broilers produced, 3,526.

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Glossary

Alluvial fan. A fan-shaped deposit of sand, gravel, and fine material dropped by a stream where its gradient lessens abruptly.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the bases of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the assorted and unassorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by melt water as it flows from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.
A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.
A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.
B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.
C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.
R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Leaching. The removal of soluble material from soil or other material by percolating water.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—few, common, and many; size—fine, medium, and coarse; and contrast—faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedisediment. A sediment that covers a pediment rather thinly. A pediment is an erosional surface that lies at the foot of a receded slope, is underlain by rock or sediment of the upland, is barren or mantled with alluvium, and displays a longitudinal profile, normally concave upward.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface

without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

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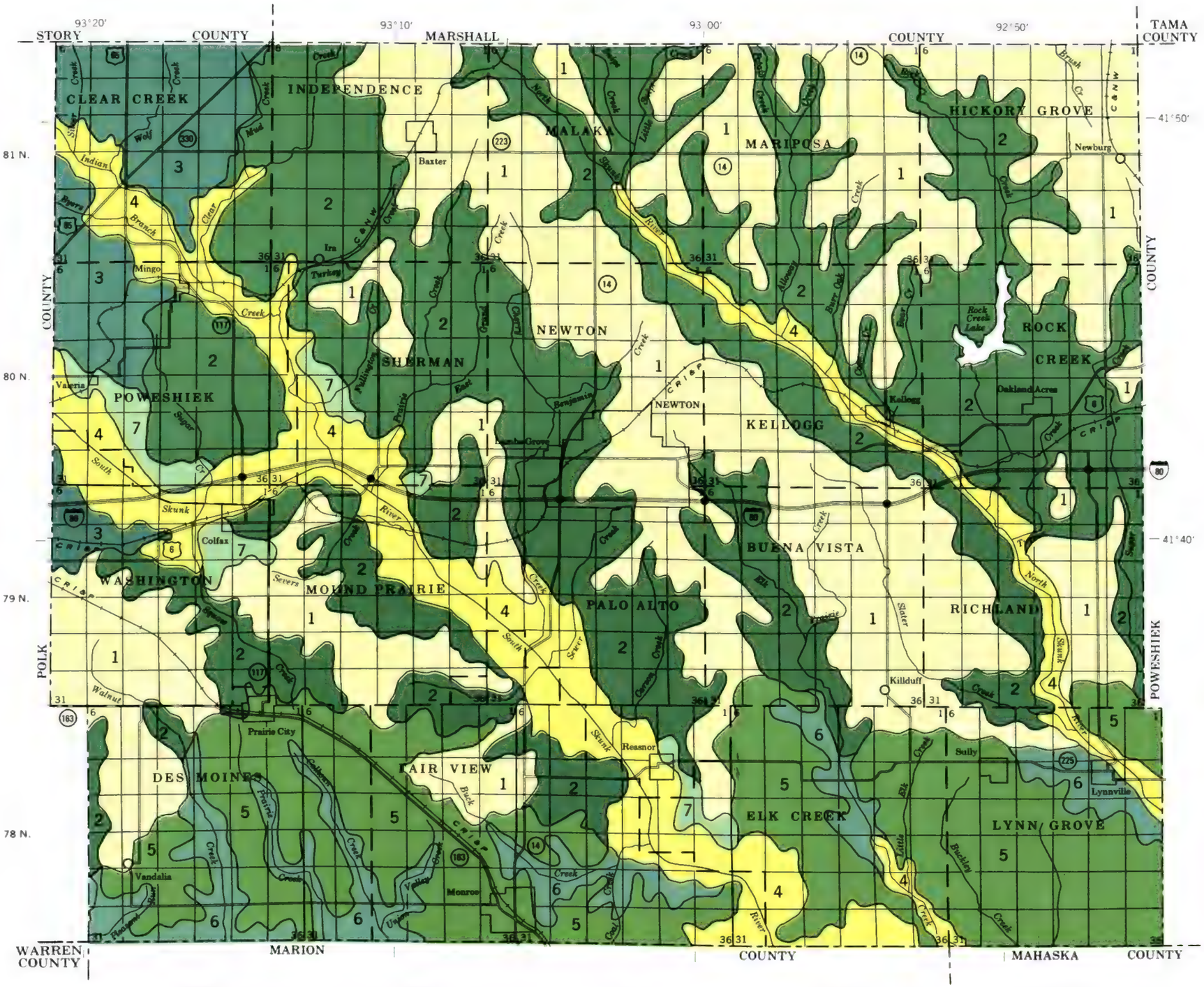

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION
COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY
DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

GENERAL SOIL MAP

JASPER COUNTY, IOWA

Scale 1:190,080
1 0 1 2 3 4 Miles

SOIL ASSOCIATIONS

1. Tama–Killduff–Muscatine association: Nearly level to moderately steep, well drained to somewhat poorly drained soils that formed in loess on uplands
2. Downs–Tama–Shelby association: Nearly level to steep, well drained and moderately well drained soils that formed in loess and glacial till on uplands
3. Clarion–Lester association: Gently sloping to moderately steep, well drained soils that formed in glacial till on uplands
4. Nodaway–Zook–Nevin association: Level and nearly level, moderately well drained to poorly drained soils that formed in silty and clayey alluvium on bottom lands
5. Otley–Mahaska association: Nearly level to strongly sloping, moderately well drained and somewhat poorly drained soils that formed in loess on uplands
6. Ladoga–Gara association: Gently sloping to very steep, moderately well drained and well drained soils that formed in loess or glacial till on uplands
7. Sparta–Chelsea–Dickinson association: Gently sloping to very steep, excessively drained to well drained soils that formed in sands on uplands and terraces

Compiled 1977

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

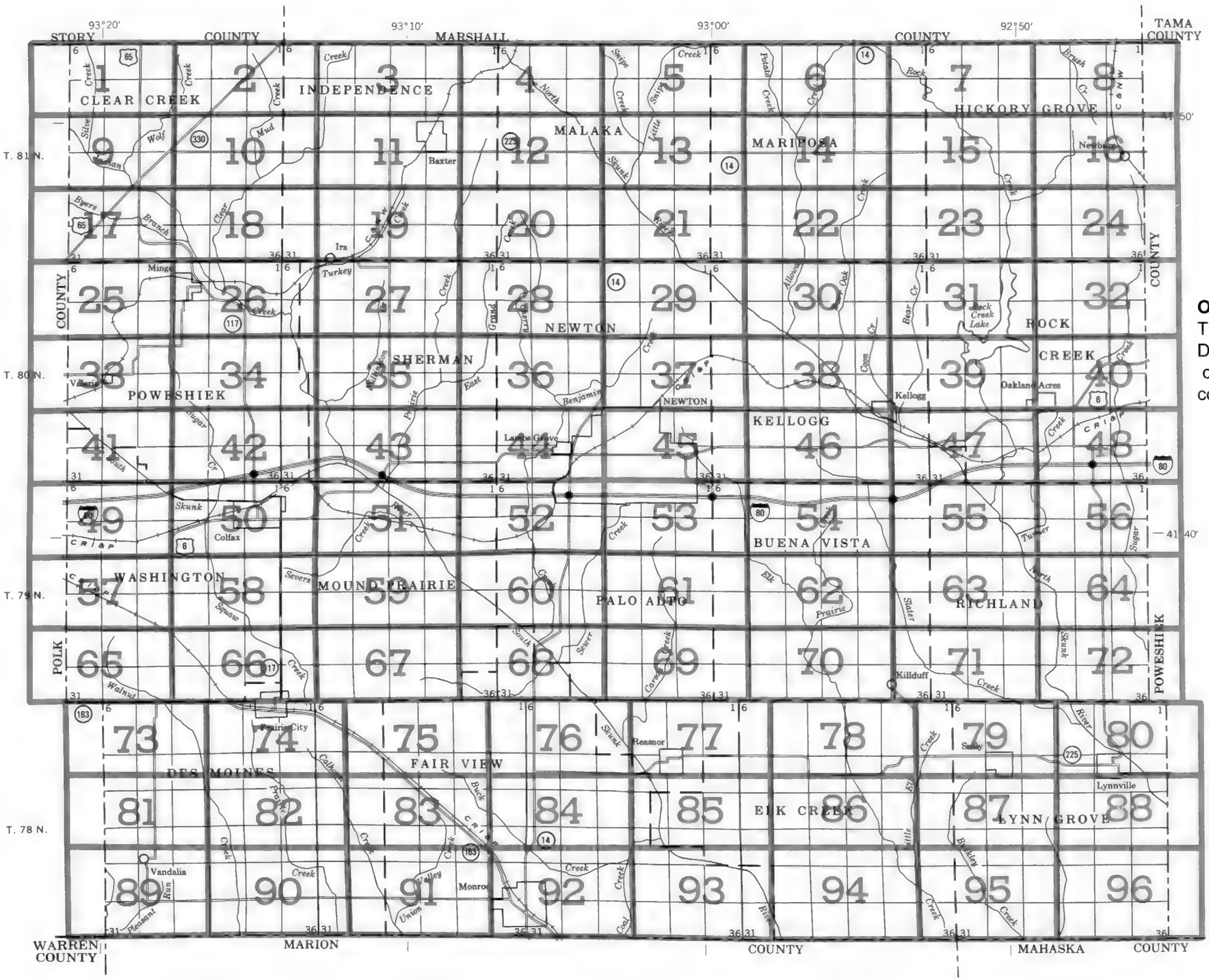
INDEX TO MAP SHEETS

JASPER COUNTY, IOWA

Scale 1:190,080

1 0 1 2 3 4 Miles

Original text from each individual map sheet read:
This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

Symbols consist of numbers or a combination of numbers and letters; for example, 8, 43, 65C, 236C2. The 1, 2, or 3 digit number designates the kind of soil or land type. A capital letter B, C, D, E, F, or G following a number indicates the class of slope. Symbols without a slope letter are those for units that are nearly level. A final number 2 or 3 following a letter indicates that the soil is moderately eroded or severely eroded respectively. The capital C or T used as a prefix indicates a channeled phase or a bench phase respectively and a plus sign used as suffix indicates an overwash phase.

SYMBOL	NAME
5B	Ackmore–Colo complex, 2 to 5 percent slopes
C5B	Ackmore–Colo complex, channeled, 2 to 5 percent slopes
7	Wiota silt loam, 0 to 2 percent slopes
8	Judson silt loam, 0 to 2 percent slopes
8B	Judson silty clay loam, 2 to 5 percent slopes
8C	Judson silty clay loam, 5 to 9 percent slopes
20C2	Killduff silty clay loam, 5 to 9 percent slopes, moderately eroded
20D2	Killduff silty clay loam, 9 to 14 percent slopes, moderately eroded
20E2	Killduff silty clay loam, 14 to 18 percent slopes, moderately eroded
24D2	Shelby loam, 9 to 14 percent slopes, moderately eroded
24E2	Shelby loam, 14 to 18 percent slopes, moderately eroded
24F2	Shelby loam, 18 to 25 percent slopes, moderately eroded
27B	Terril loam, 2 to 5 percent slopes
41B	Sparta loamy fine sand, 1 to 5 percent slopes
41C2	Sparta loamy fine sand, 5 to 9 percent slopes, moderately eroded
41D2	Sparta loamy fine sand, 9 to 18 percent slopes, moderately eroded
43	Bremer silty clay loam, 0 to 2 percent slopes
54	Zook silty clay loam, 0 to 2 percent slopes
55	Nicollet loam, 1 to 3 percent slopes
62D	Storden loam, 5 to 14 percent slopes
62E	Storden loam, 14 to 18 percent slopes
62F	Storden loam, 18 to 25 percent slopes
63C	Chelsea loamy fine sand, 4 to 9 percent slopes
63D	Chelsea loamy fine sand, 9 to 14 percent slopes
63E	Chelsea loamy fine sand, 14 to 25 percent slopes
65E	Lindley loam, 14 to 18 percent slopes
65E3	Lindley soils, 14 to 18 percent slopes, severely eroded
65F	Lindley loam, 18 to 25 percent slopes
65G	Lindley loam, 25 to 40 percent slopes
76B	Ladoga silt loam, 2 to 5 percent slopes
76C2	Ladoga silt loam, 5 to 9 percent slopes, moderately eroded
76D2	Ladoga silt loam, 9 to 14 percent slopes, moderately eroded
80C2	Clinton silt loam, 5 to 9 percent slopes, moderately eroded
80D2	Clinton silt loam, 9 to 14 percent slopes, moderately eroded
80D3	Clinton soils, 9 to 14 percent slopes, severely eroded
80E2	Clinton silt loam, 14 to 18 percent slopes, moderately eroded
88	Nevin silty clay loam, 0 to 2 percent slopes
93D2	Shelby–Adair complex, 9 to 14 percent slopes, moderately eroded
93E2	Shelby–Adair complex, 14 to 18 percent slopes, moderately eroded
94D2	Caleb and Mystic soils, 9 to 14 percent slopes, moderately eroded
94E2	Caleb and Mystic soils, 14 to 18 percent slopes, moderately eroded
107	Webster silty clay loam, 0 to 2 percent slopes
117	Garwin–Sperry complex, 0 to 2 percent slopes
118	Garwin silty clay loam, 0 to 2 percent slopes
119	Muscatine silty clay loam, 0 to 2 percent slopes
120	Tama silty clay loam, 0 to 2 percent slopes
120B	Tama silty clay loam, 2 to 5 percent slopes
120C2	Tama silty clay loam, 5 to 9 percent slopes, moderately eroded
120D2	Tama silty clay loam, 9 to 14 percent slopes, moderately eroded
T120B	Tama silty clay loam, benches, 2 to 5 percent slopes
T120C	Tama silty clay loam, benches, 5 to 9 percent slopes
122	Sperry silt loam, 0 to 1 percent slopes
133	Colo silty clay loam, 0 to 2 percent slopes
133 +	Colo silt loam, overwash, 0 to 2 percent slopes
135	Coland clay loam, 0 to 2 percent slopes
135B	Coland clay loam, 2 to 5 percent slopes
138B	Clarion loam, 2 to 5 percent slopes
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded
138D2	Clarion loam, 9 to 14 percent slopes, moderately eroded
138E2	Clarion loam, 14 to 18 percent slopes, moderately eroded
162	Downs silt loam, 0 to 2 percent slopes
162B	Downs silt loam, 2 to 5 percent slopes
162C2	Downs silt loam, 5 to 9 percent slopes, moderately eroded
162D2	Downs silt loam, 9 to 14 percent slopes, moderately eroded
162E2	Downs silt loam, 14 to 18 percent slopes, moderately eroded
T162B	Downs silt loam, benches, 2 to 5 percent slopes
T162C	Downs silt loam, benches, 5 to 9 percent slopes
163B	Fayette silt loam, 2 to 5 percent slopes
163C2	Fayette silt loam, 5 to 9 percent slopes, moderately eroded
163D2	Fayette silt loam, 9 to 14 percent slopes, moderately eroded
163D3	Fayette soils, 9 to 14 percent slopes, severely eroded
163E2	Fayette silt loam, 14 to 18 percent slopes, moderately eroded
163F2	Fayette silt loam, 18 to 25 percent slopes, moderately eroded
168E2	Hayden loam, 14 to 18 percent slopes, moderately eroded
168F	Hayden loam, 18 to 25 percent slopes
168G	Hayden loam, 25 to 40 percent slopes
172	Wabash silty clay loam, 0 to 2 percent slopes
174	Bolan loam, 0 to 2 percent slopes
175B	Dickinson fine sandy loam, 2 to 5 percent slopes
175C	Dickinson fine sandy loam, 5 to 9 percent slopes
175D	Dickinson fine sandy loam, 9 to 14 percent slopes
179D2	Gara loam, 9 to 14 percent slopes, moderately eroded
179E2	Gara loam, 14 to 18 percent slopes, moderately eroded
179F2	Gara loam, 18 to 25 percent slopes, moderately eroded
179G	Gara loam, 25 to 40 percent slopes
185E2	Bauer silt loam, 9 to 18 percent slopes, moderately eroded
185F2	Bauer silt loam, 18 to 40 percent slopes, moderately eroded
192D2	Adair clay loam, 9 to 14 percent slopes, moderately eroded
212	Kennebec silt loam, 0 to 2 percent slopes
220	Nodaway silt loam, 0 to 2 percent slopes
222C2	Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded
222D2	Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded
225	Lawler loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes
226	Lawler loam, 32 to 40 inches to sand and gravel, 0 to 2 percent slopes
236B	Lester loam, 2 to 5 percent slopes
236C2	Lester loam, 5 to 9 percent slopes, moderately eroded
236D2	Lester loam, 9 to 14 percent slopes, moderately eroded
273B	Olmitz loam, 2 to 5 percent slopes
273C	Olmitz loam, 5 to 9 percent slopes
279	Tarntor silty clay loam, 0 to 2 percent slopes
280	Mahaska silty clay loam, 0 to 2 percent slopes
281B	Otley silty clay loam, 2 to 5 percent slopes
281C2	Otley silty clay loam, 5 to 9 percent slopes, moderately eroded
281D2	Otley silty clay loam, 9 to 14 percent slopes, moderately eroded
284B	Flagler sandy loam, 1 to 4 percent slopes
291	Atterberry silt loam, 0 to 2 percent slopes
293G	Chelsea–Fayette complex, 25 to 40 percent slopes
315	Alluvial land–Nodaway complex, 0 to 2 percent slopes
C315	Alluvial land, channeled
354	Marsh
428B	Ely silty clay loam, 2 to 5 percent slopes
430	Ackmore silt loam, 0 to 2 percent slopes
453	Tuskeego silt loam, 0 to 1 percent slopes
507	Canisteo silty clay loam, 0 to 2 percent slopes
570B2	Nira silty clay loam, 2 to 5 percent slopes, moderately eroded
570C2	Nira silty clay loam, 5 to 9 percent slopes, moderately eroded
570D2	Nira silty clay loam, 9 to 14 percent slopes, moderately eroded
620C2	Port Byron silt loam, 5 to 9 percent slopes, moderately eroded
620D2	Port Byron silt loam, 9 to 14 percent slopes, moderately eroded
620E2	Port Byron silt loam, 14 to 18 percent slopes, moderately eroded
620F2	Port Byron silt loam, 18 to 25 percent slopes, moderately eroded
742B	Martinsburg silt loam, 2 to 5 percent slopes
742C	Martinsburg silt loam, 5 to 9 percent slopes
792D2	Armstrong loam, 9 to 14 percent slopes, moderately eroded
822D2	Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded
822E2	Lamoni silty clay loam, 14 to 18 percent slopes, moderately eroded
993D2	Gara–Armstrong loams, 9 to 14 percent slopes, moderately eroded
993E2	Gara–Armstrong loams, 14 to 18 percent slopes, moderately eroded
993E3	Gara–Armstrong complex, 14 to 18 percent slopes, severely eroded

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool (Davis Airstrip; FLOOD POOL LINE)

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate (70)
- Federal (410)
- State (52)
- County, farm or ranch (378)

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small (water)

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) (Indian Mound)
- Located object (label) (Tower)
- Tank (label) (GAS)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Crossable with tillage implements
- Not crossable with tillage implements
- Drainage end
- Canals or ditches
- Double-line (label) (CANAL)
- Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial (water)
- Intermittent (Int)

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS (174, 236C2)

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

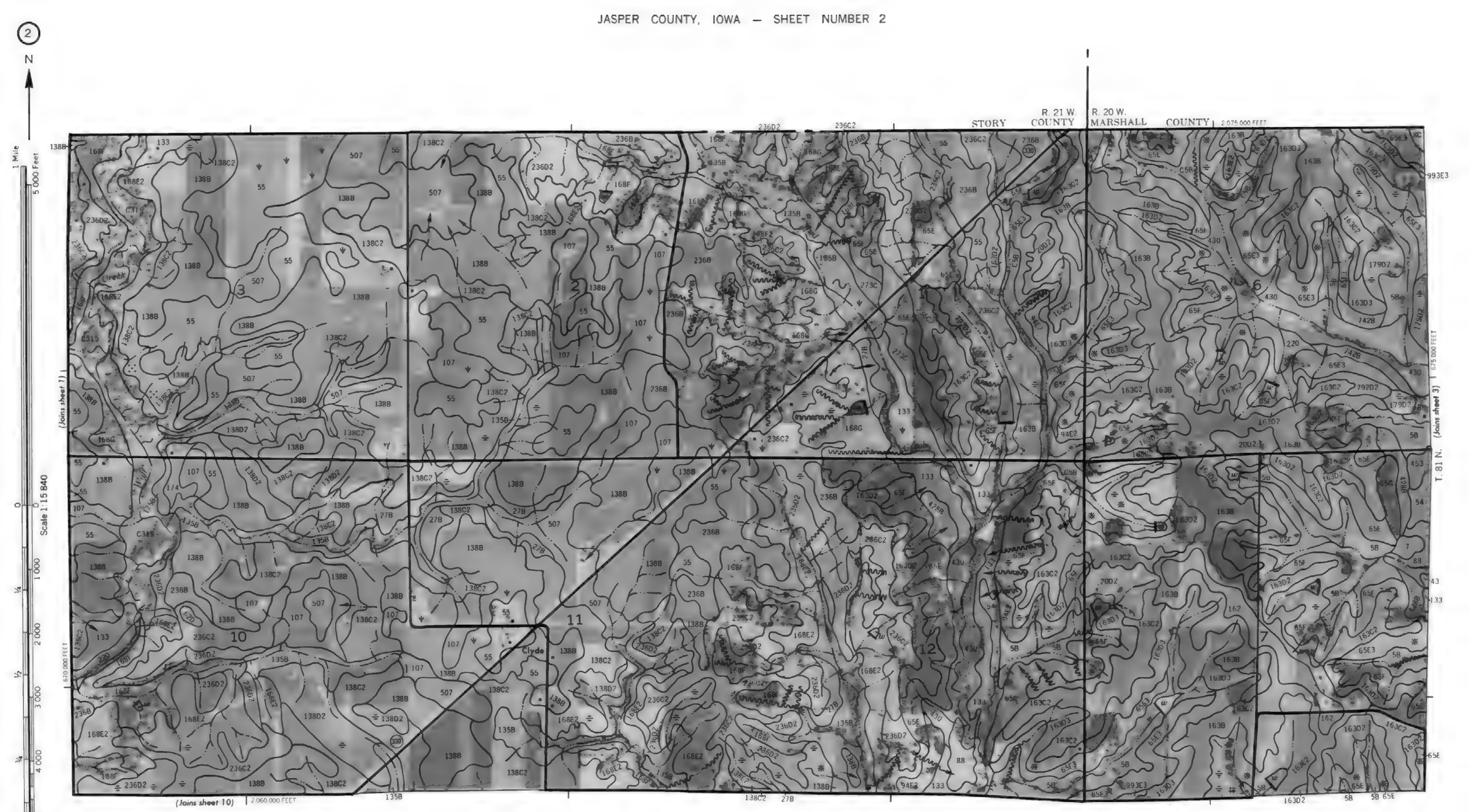
SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot (red)
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Clay Spot (gray) up to 2 acres in size
- Eroded areas up to 10 acres in size
- Shale outcrop
- Till outcrop up to 2 acres in size
- Gravel Pit — G.P.
- Sewage Lagoon — S.L.
- Borrow Pit — B.P.
- Made Land — M.L.
- Mine Dump — M.D.
- Strip Mine — S.M.

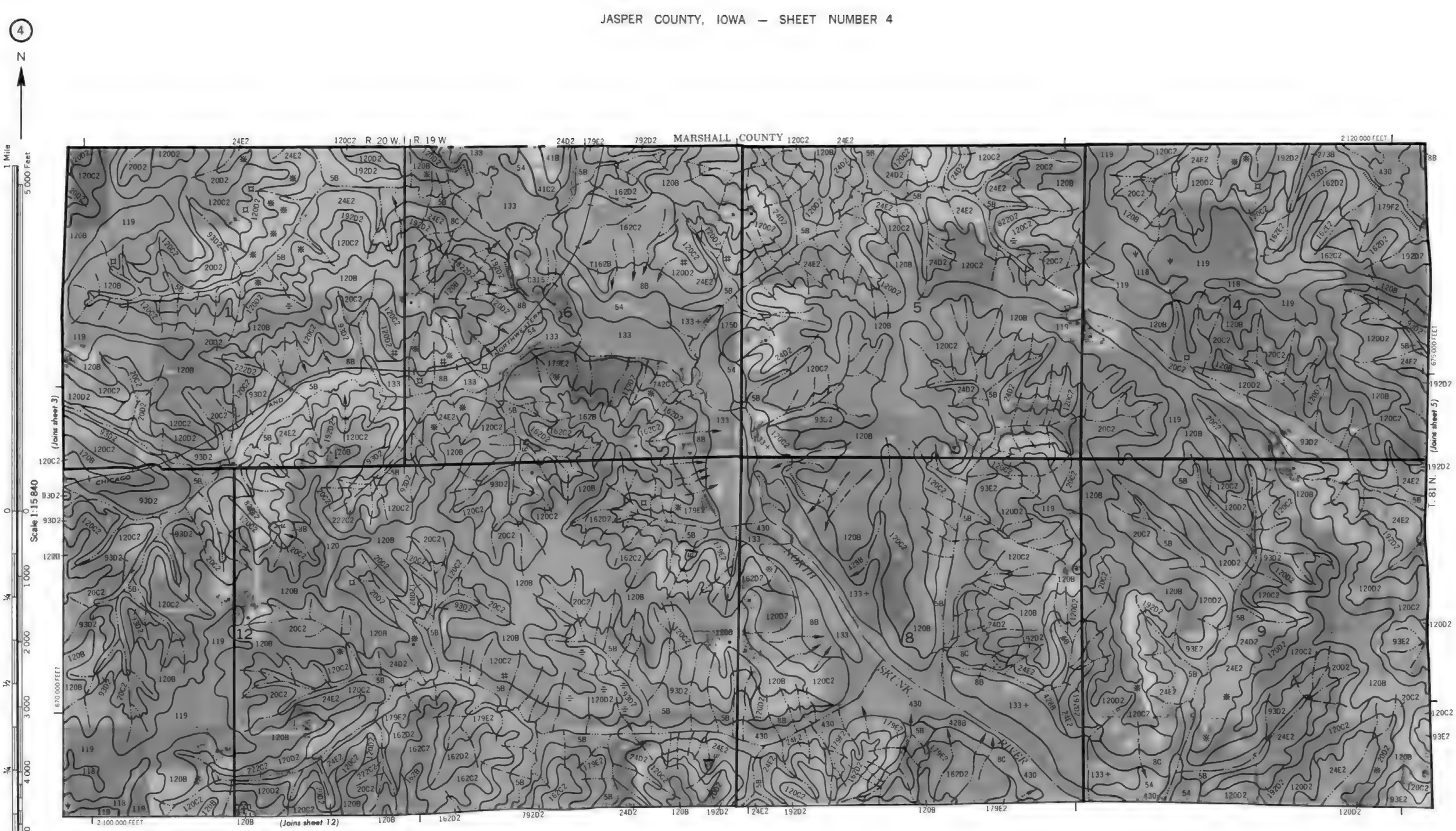
JASPER COUNTY, IOWA — SHEET NUMBER 1

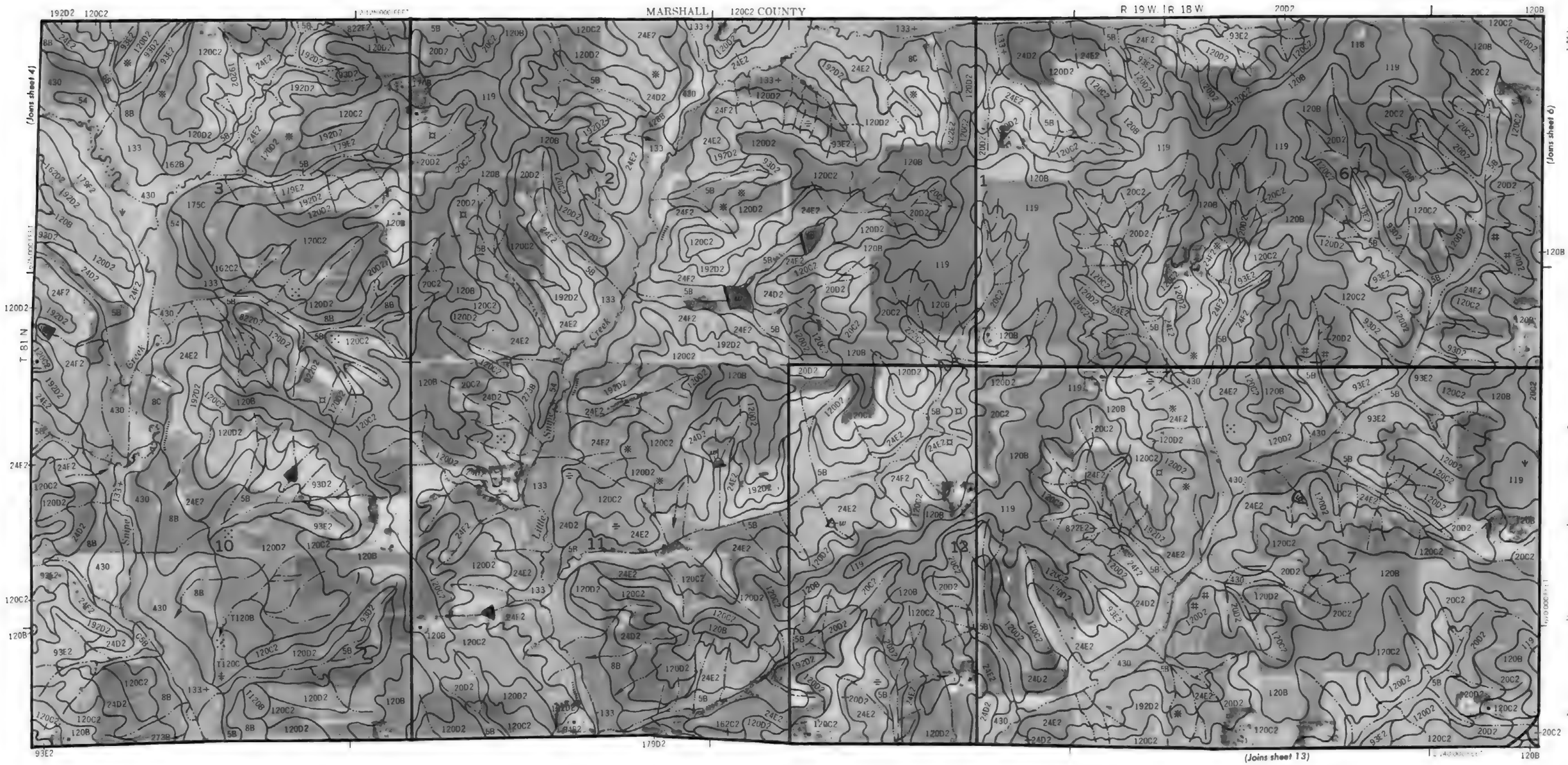
JASPER COUNTY, IOWA — SHEET NUMBER 2

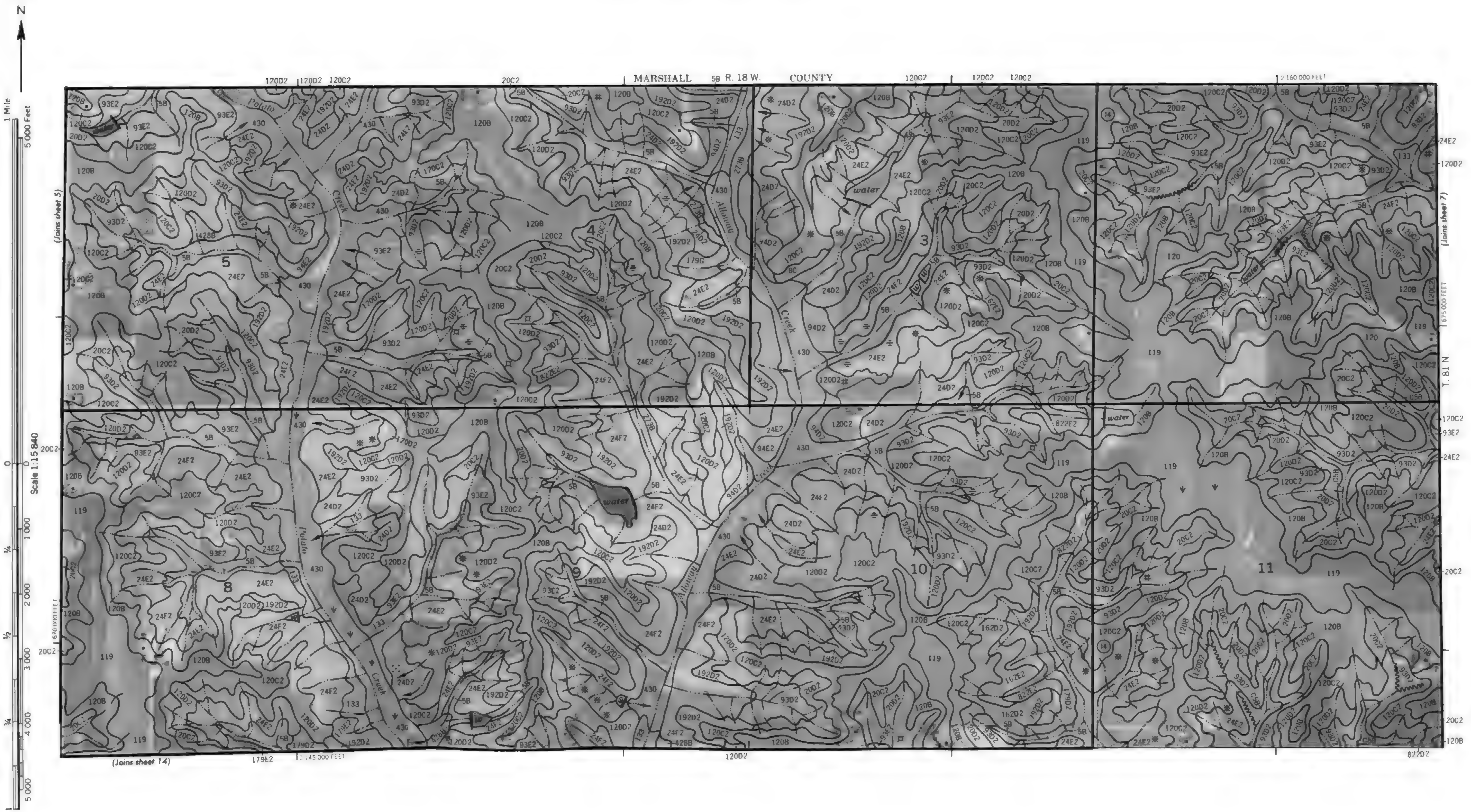


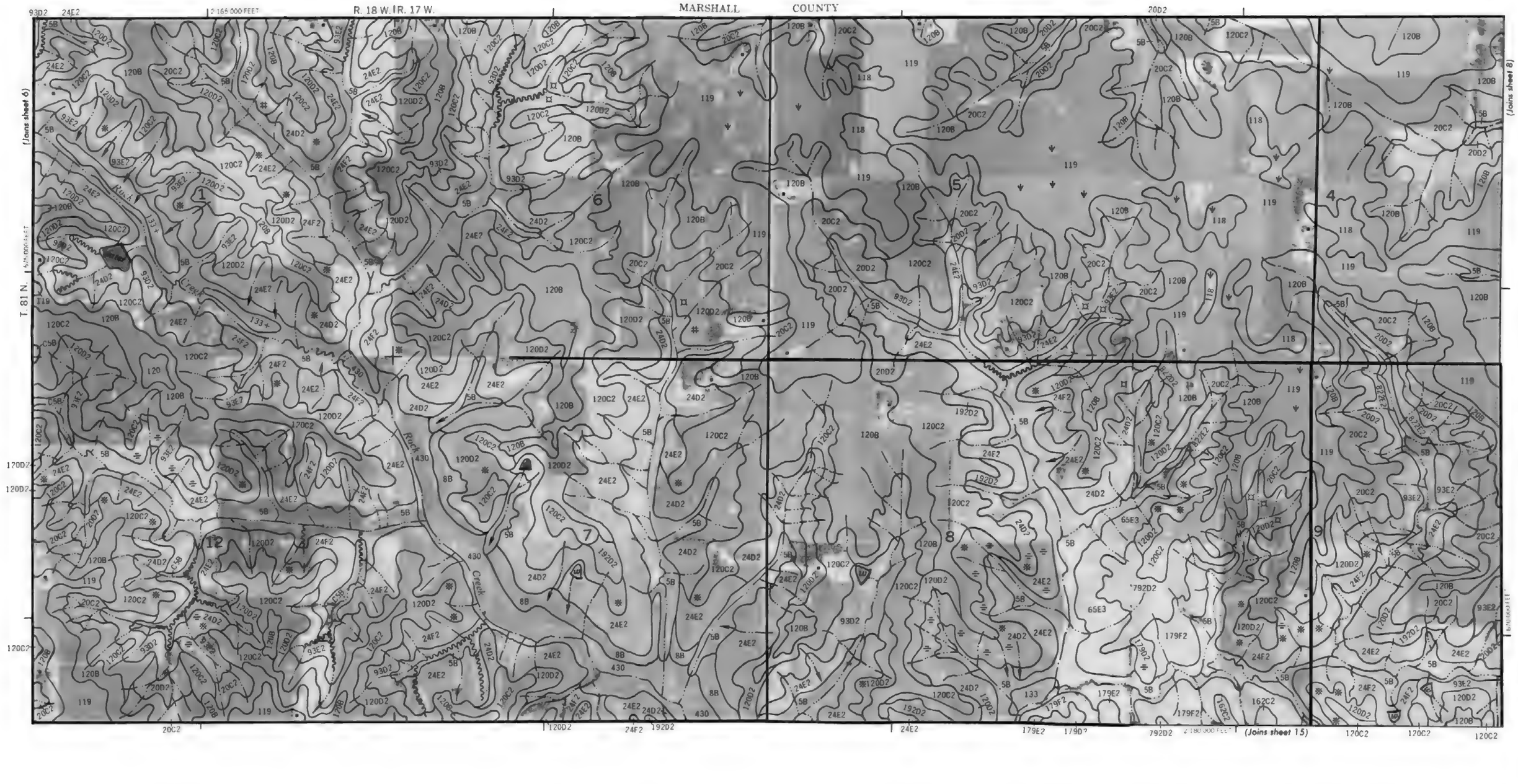
JASPER COUNTY, IOWA — SHEET NUMBER 3

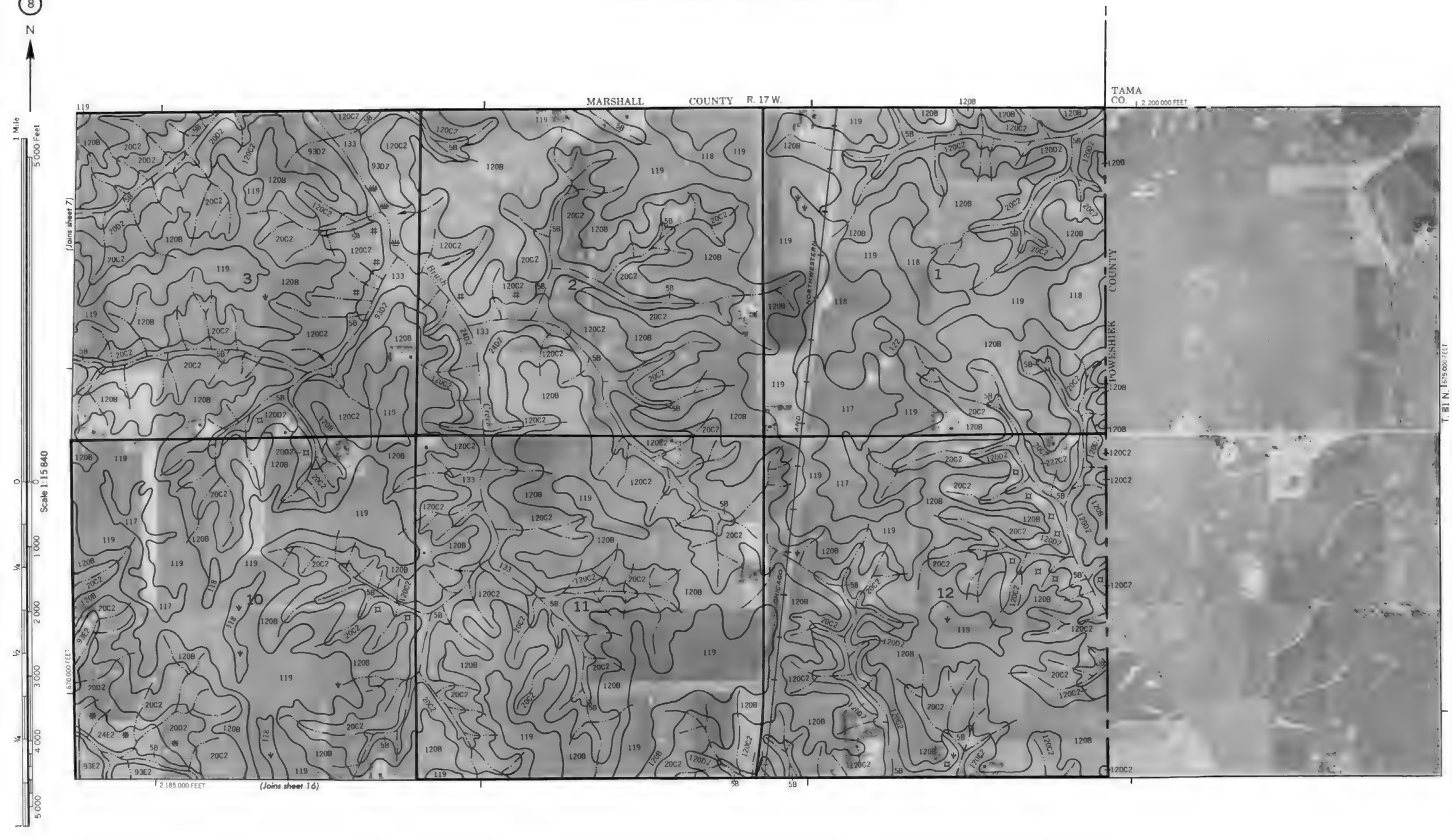
JASPER COUNTY, IOWA — SHEET NUMBER 4



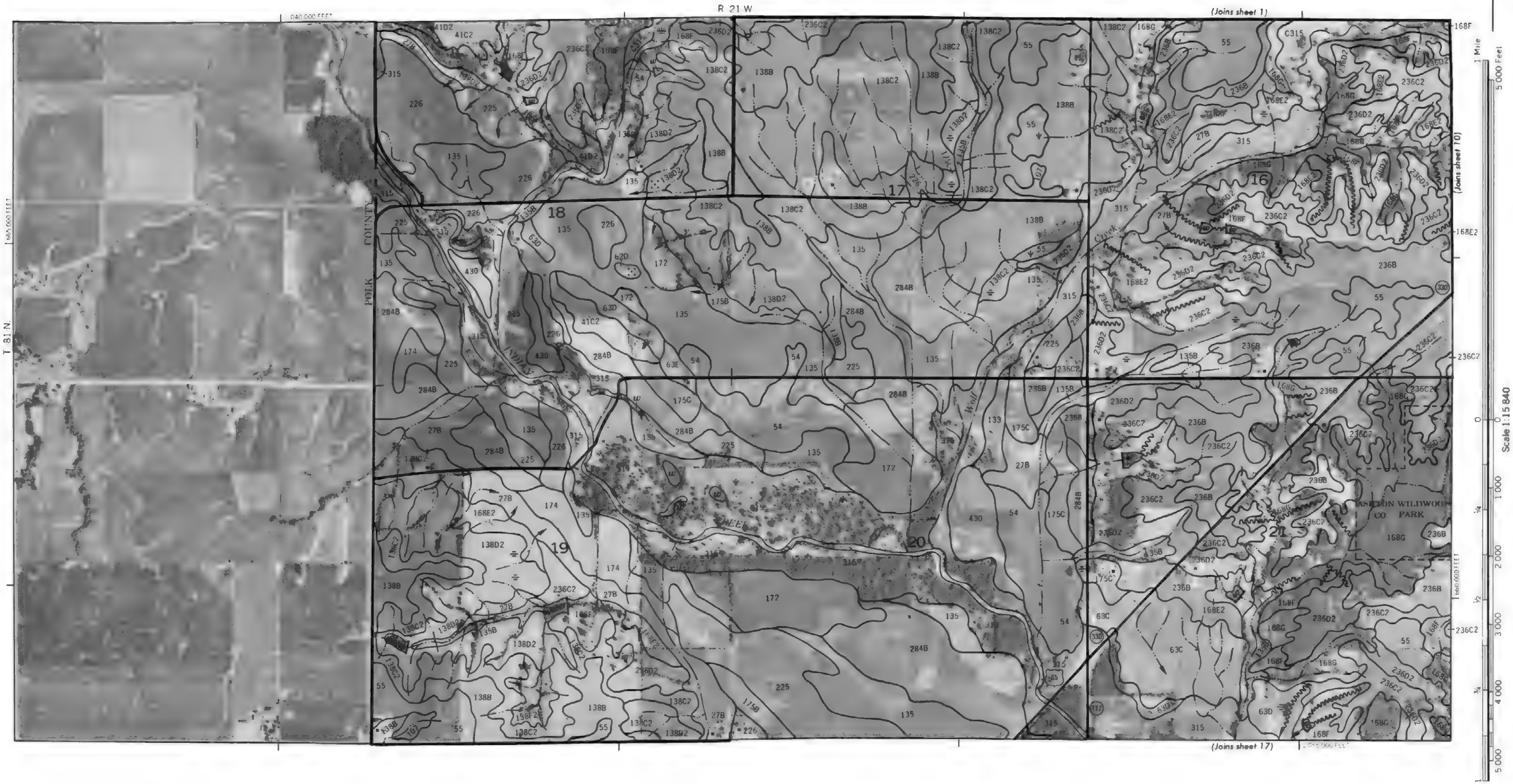

MARSHALL COUNTY
R 19 W. | R 18 W
T 81 N
(Joins sheet 4)
(Joins sheet 6)
(Joins sheet 13)
Creek
Snipe
Little
1
2
3
6
7
10
11
13
N
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5 000 Feet
Scale 1:15 840
MARSHALL COUNTY
R. 18 W.
T. 81 N.
(Joins sheet 5)
(Joins sheet 7)
(Joins sheet 14)
2 160 000 FEET
2 145 000 FEET
675 000 FEET
670 000 FEET
Potato Creek
Alloway Creek
water


R. 18 W.
R. 17 W.
MARSHALL COUNTY
T. 81 N.
2 165 000 FEET
(Joins sheet 6)
(Joins sheet 8)
(Joins sheet 15)
Rush Creek
Rock Creek
N
1 Mile
5,000 Feet
Scale 1:15 840


8
N
1 Mile
5 000 Feet
Scale 1:15 840
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000
MARSHALL COUNTY R. 17 W.
TAMA CO.
POWESHIEK COUNTY
(Joins sheet 7)
(Joins sheet 16)
2 200 000 FEET
2 185 000 FEET
670 000 FEET
675 000 FEET
T. 81 N.
Brush Creek
NORTHWESTERN
CHICAGO AND
1
2
3
10
11
12

N


R 21 W
T 81 N
(Joins sheet 1)
(Joins sheet 10)
(Joins sheet 17)
POLK COUNTY
Creek
18
17
16
19
20
21
ASHTON WILDWOOD CO PARK
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000

(10)

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0 ¼ 1 000 ½ 2 000 ¾ 4 000 5 000

(Joins sheet 2)

(Joins sheet 9)

(Joins sheet 18)

(Joins sheet 11)

R. 21 W. | R. 20 W.

T. 81 N

2 075 000 FEET

665 000 FEET

15 14 13 18 22 23 24 19

Creek

N

R 20 W

(Joins sheet 3)

(Joins sheet 10)

(Joins sheet 12)

(Joins sheet 19)

T. 81 N

Baxter

Turkey Creek

CHICAGO NORTHWESTERN R.R.

SEWAGE LAGOON

1 Mile

5 000 Feet

Scale 1:15 840

(12)

N

R. 20 W. | R. 19 W.

(Joins sheet 4)

(Joins sheet 11)

(Joins sheet 13)

(Joins sheet 20)

T. 81 N.

2 120 000 FEET

2 100 000 FEET

1 Mile

5 000 Feet

Scale 1:15 840

0 1/4 1/2 3/4 1

1 000 2 000 3 000 4 000 5 000

460 000 FEET

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 19 W. | R. 18 W.

(Joins sheet 5)

(Joins sheet 12)

(Joins sheet 14)

(Joins sheet 21)

T. 81 N.

| 660 000 FEET

| 240 000 FEET

15 14 13 18

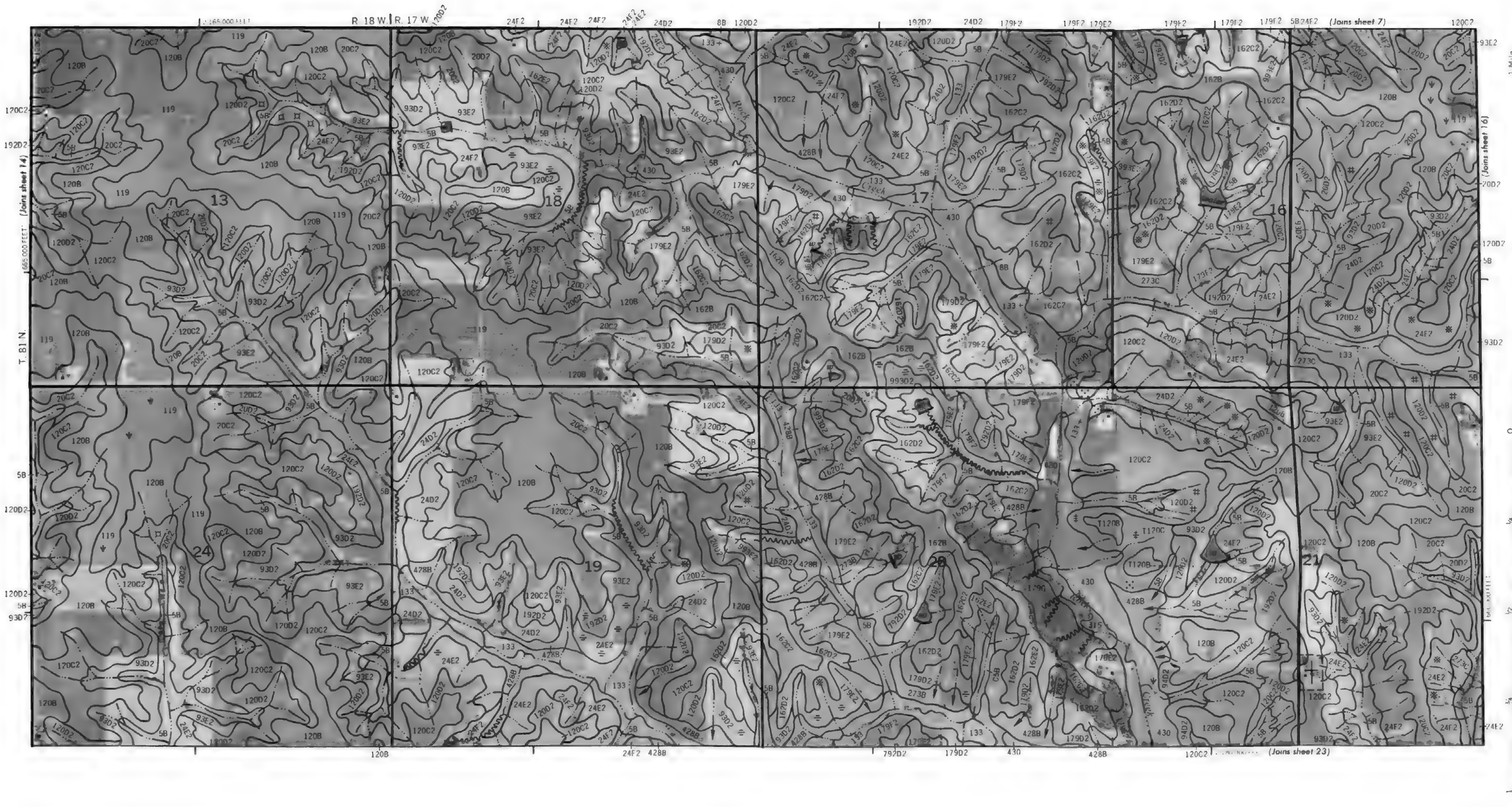
22 23 24 19

SNAKE CREEK

NORTH SKUNK RIVER

Snipe Creek

JASPER COUNTY, IOWA — SHEET NUMBER 14


R. 18 W.
R. 17 W.
T. 81 N.
(Joins sheet 14)
(Joins sheet 7)
(Joins sheet 16)
(Joins sheet 23)
13
18
17
16
24
19
20
21
Rock Creek
15
N
1 Mile
5 000 Feet
Scale 1:15 840

16

N

1 Mile 5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

(Joins sheet 8)

(Joins sheet 15)

(Joins sheet 24)

R 17 W

2 200 000 FEET

2 195 000 FEET

T. 81 N.

665 000 FEET

POWESHIEK COUNTY

Newburg

CHICAGO, ROCK ISLAND & PACIFIC

CHICAGO, MILWAUKEE & ST. PAUL

CHICAGO & NORTH WESTERN

15 14 13

22 23 24

N

R. 21 W

2 040 000 FEET

555 000 FEET

T. 81 N

(Joins sheet 9) 63D

236D2

168F

(Joins sheet 18)

284B

650 000 FEET

(Joins sheet 25)

2 055 000 FEET

POLK COUNTY

Byers Branch

CREEK

30 29 28 31 32 33

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

18

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 10)

(Joins sheet 17)

(Joins sheet 26)

(Joins sheet 19)

R. 21 W. | R. 20 W.

T. 81 N.

2075 000 FEET

1655 000 FEET

Indian Creek

Clear Creek

26 27 25 30 34 35 36 31


N
R 20 W.
T 81 N.
(Joins sheet 18)
(Joins sheet 11)
(Joins sheet 20)
(Joins sheet 27)
water
Turkey Creek
Prairie Creek
CHICAGO NORTHWESTERN
29
28
27
26
32
33
34
35
1 Mile
5 000 Feet
Scale 1:15 840

JASPER COUNTY, IOWA — SHEET NUMBER 20

20

N

R. 20 W. | R. 19 W.

T. 81 N.

(Joins sheet 12)

(Joins sheet 19)

(Joins sheet 21)

(Joins sheet 28)

2 100 000 FEET

1 Mile

5 000 Feet

Scale 1:15 840

1 000 0 1 000 2 000 3 000 4 000 5 000 FEET

¼ ½ ¾ 1

N

R. 19 W | R. 18 W

T 81 N.

(Joins sheet 20)

(Joins sheet 13)

(Joins sheet 22)

(Joins sheet 29)

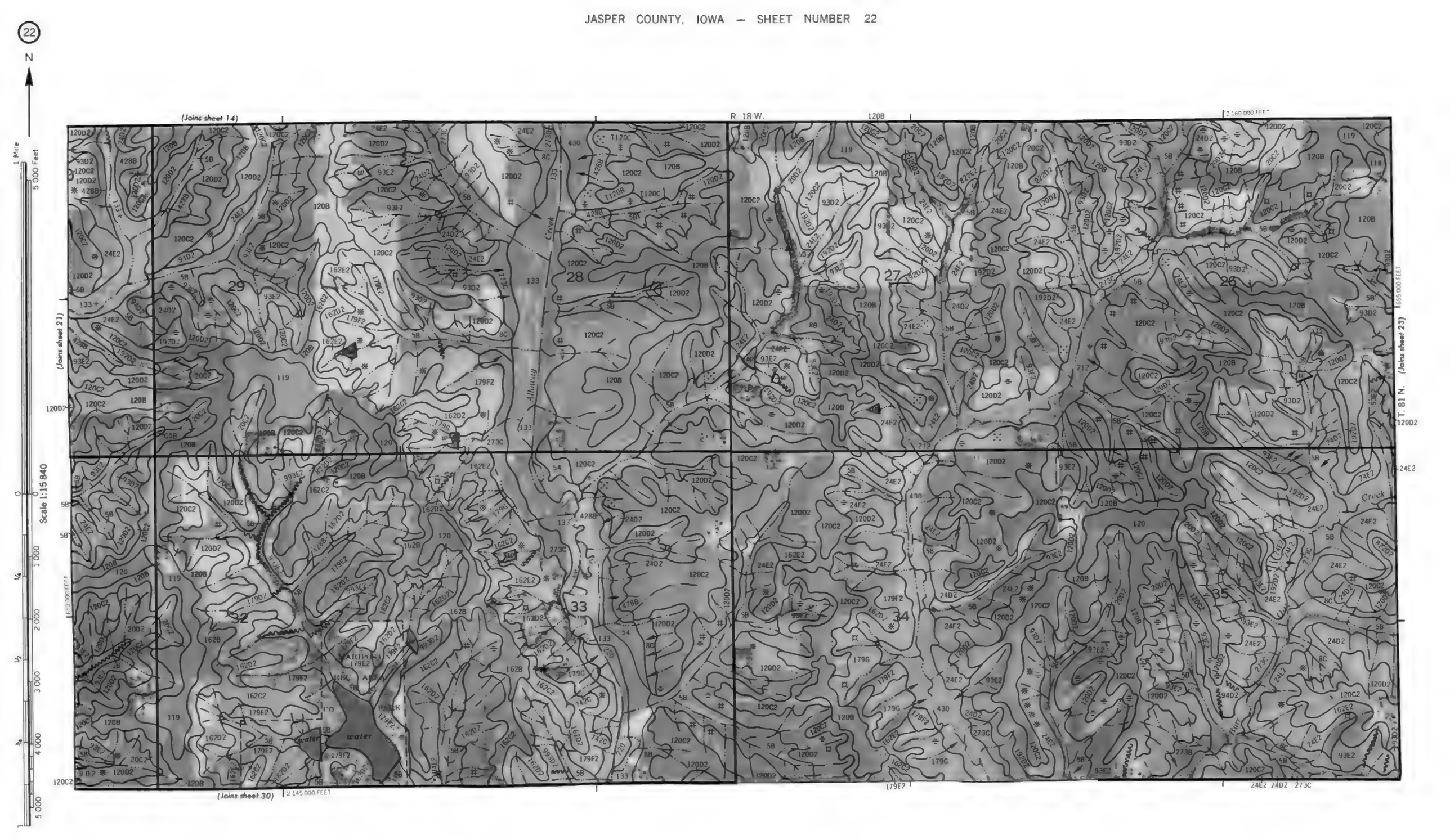
SKUNK RIVER

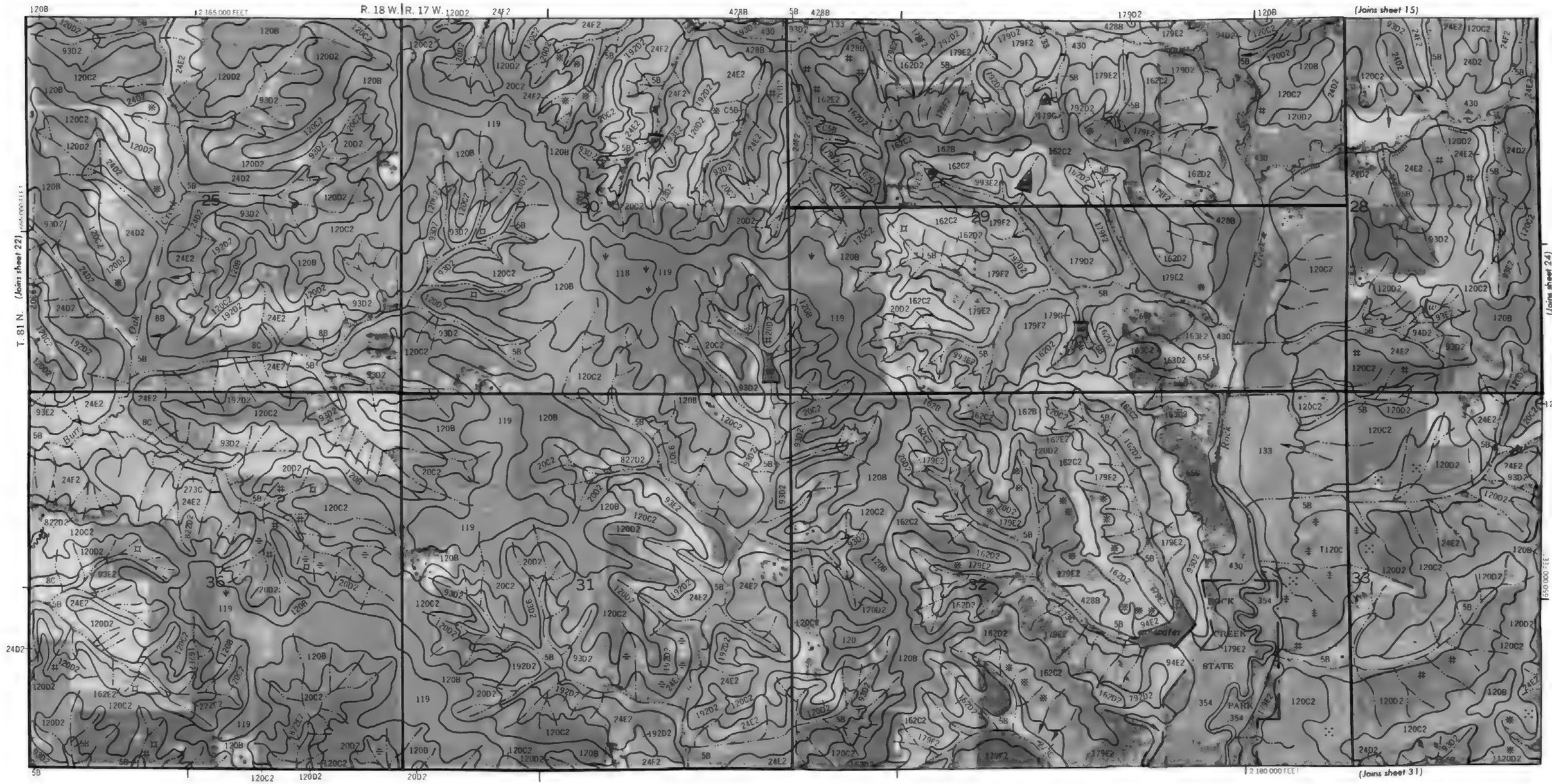
1 Mile

5 000 Feet

Scale 1:15 840

JASPER COUNTY, IOWA — SHEET NUMBER 22




R. 18 W.
R. 17 W.
T. 81 N.
(Joins sheet 22)
(Joins sheet 15)
(Joins sheet 24)
(Joins sheet 31)
2 165 000 FEET
2 180 000 FEET
650 000 FEET
25
30
29
28
36
31
32
33
Oak
Burr
Rock
Creek
ROCK CREEK STATE PARK
23
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000

24

N

1 Mile 5 000 Feet

Scale 1:15 840

(Joins sheet 16)

R 17 W

2 205 000 FEET

(Joins sheet 23)

555 000 FEET

POWESHIEK COUNTY

T. 81 N.

(Joins sheet 32)

2 185 000 FEET

25

N

2 040 000 FEET

R. 21 W

(Joins sheet 17)

T 80 N.

COUNTY

(Joins sheet 26)

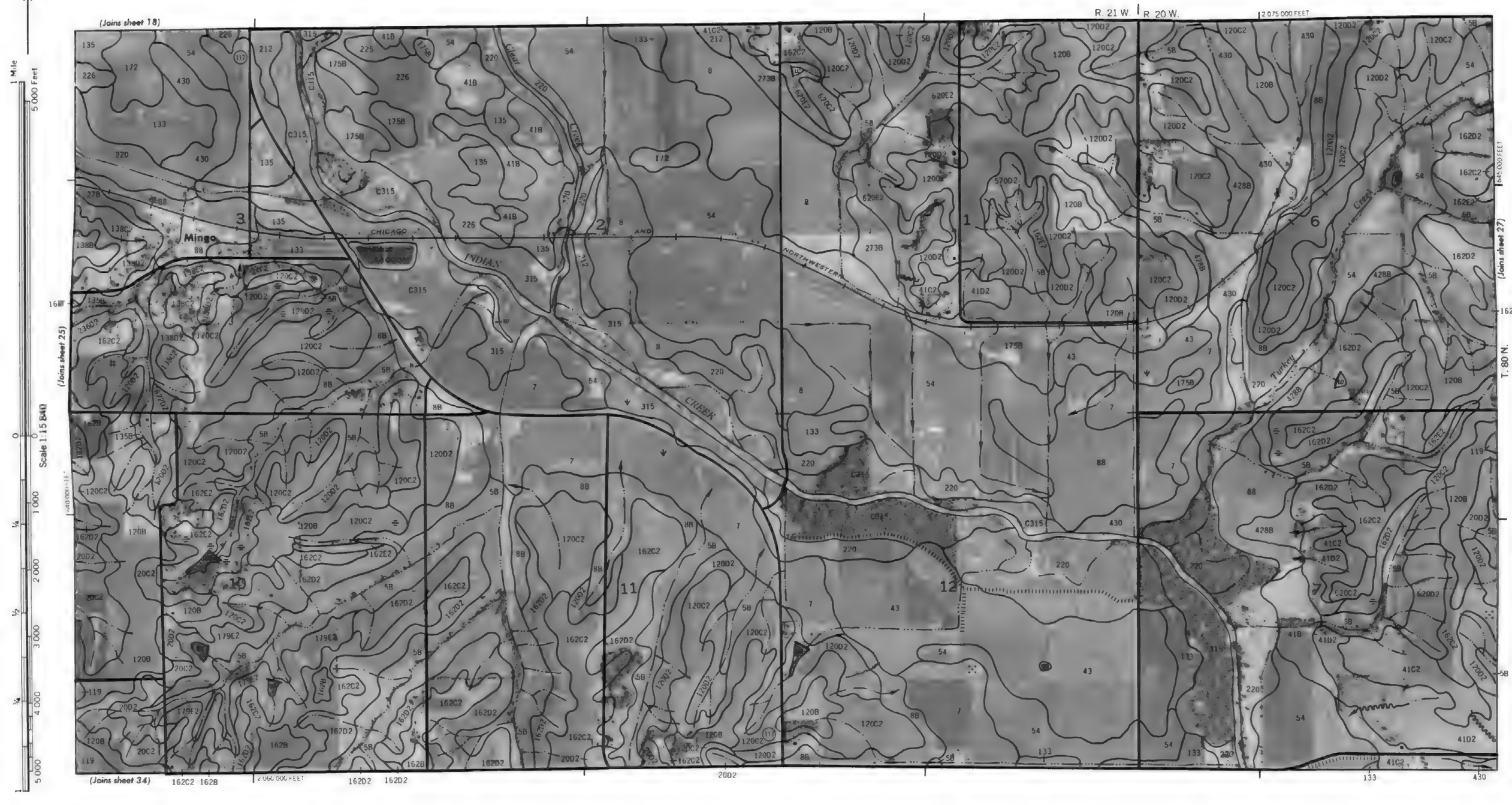
(Joins sheet 33)

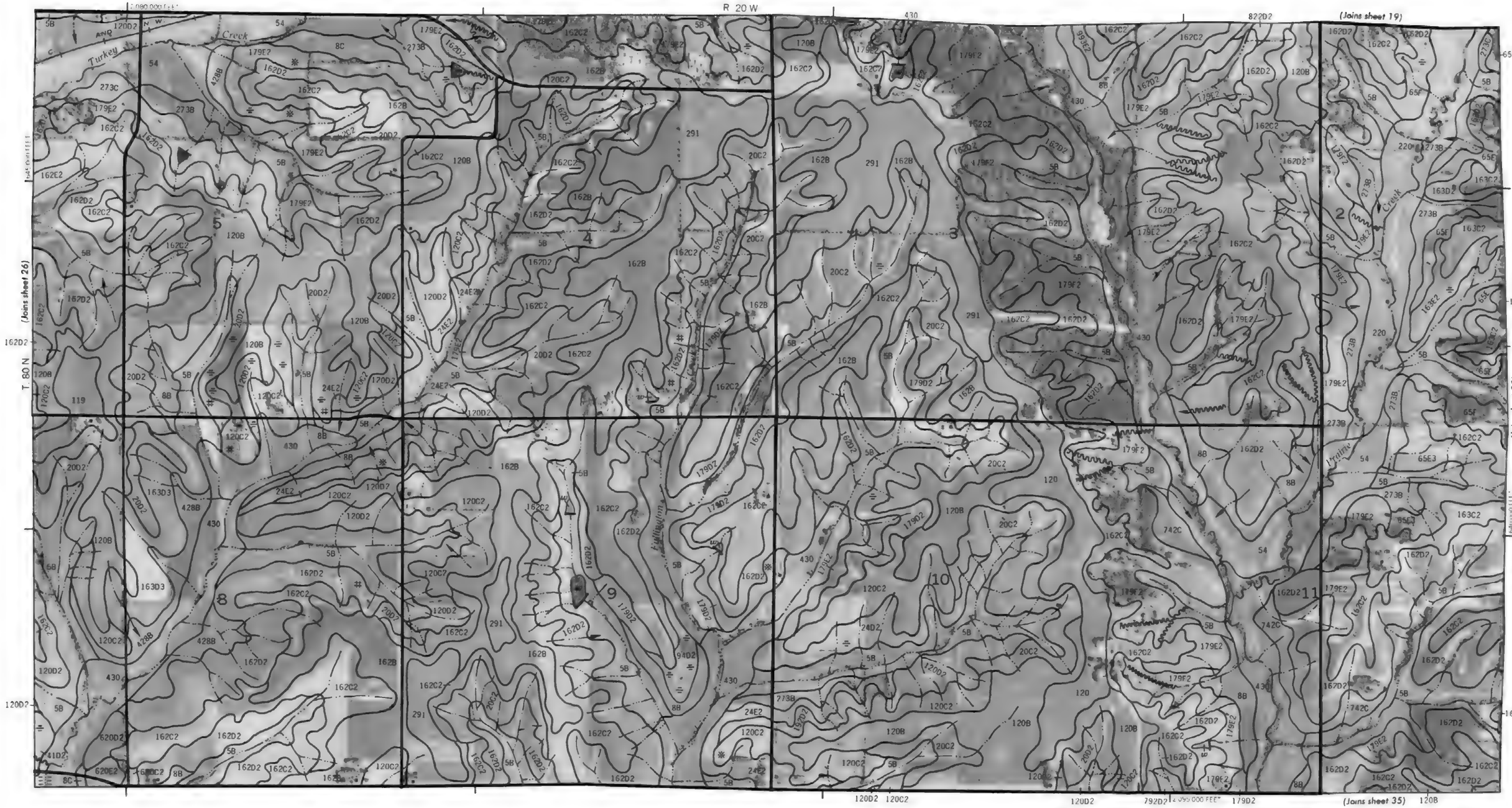
2 055 000 FEET

1 Mile

5 000 Feet

Scale 1:15 840


(26)
N
1 Mile
5,000 Feet
Scale 1:15 840
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000
(Joins sheet 18)
(Joins sheet 25)
(Joins sheet 34)
(Joins sheet 27)
R. 21 W.
R. 20 W.
T. 80 N.
2 075 000 FEET
2 080 000 FEET
Mingo
CHICAGO
AND
NORTHWESTERN
Clear Creek
INDIAN
CREEK
Turkey
C315
1
2
3
6
10
11
12


R 20 W
(Joins sheet 19)
(Joins sheet 26)
T. 80 N
(Joins sheet 28)
(Joins sheet 35)
Turkey Creek
Lyttle Creek
Scale 1:15 840
1 Mile
5,000 Feet

JASPER COUNTY, IOWA — SHEET NUMBER 28

28

N

R. 20 W. | R. 19 W.

(Joins sheet 20)

(Joins sheet 27)

(Joins sheet 29)

(Joins sheet 36)

T. 80 N.

1 Mile

5 000 Feet

Scale 1:15 840

29

N

R. 19 W. R. 18 W.

T. 80 N

(Joins sheet 21)

(Joins sheet 28)

(Joins sheet 30)

(Joins sheet 37)

2 125 000 FEET

2 140 000 FEET

NORTH SKUNK RIVER

1 Mile

5 000 Feet

Scale 1:15 840

30

N

1 Mile

5,000 Feet

Scale 1:15 840

(Joins sheet 22)

R. 18 W.

2 160 000 FEET

(Joins sheet 29)

(Joins sheet 31)

T. 80 N.

(Joins sheet 38)

2 145 000 FEET

645 000 FEET

SKUNK RIVER

SKUNK RIVER

HURT

1 2 3 4 5 6 7 8 9 10 11

N

R. 18 W. | R. 17 W.

(Joins sheet 30)

(Joins sheet 23)

(Joins sheet 32)

(Joins sheet 39)

T. 80 N

ROCK CREEK STATE PARK

ROCK CREEK LAKE

Rock Creek

Scale 1:15 840

1 Mile

5 000 Feet

32

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 24)

R. 17 W.

2 205 000 FEET

(Joins sheet 31)

T 80 N.

POWESHIEK COUNTY

2 185 000 FEET

(Joins sheet 40)

N

R 21 W

T. 80 N

POLK COUNTY

(Joins sheet 25)

(Joins sheet 34)

(Joins sheet 41)

Valeria

CHICAGO

Scale 1:15 840

1 Mile 5 000 Feet

JASPER COUNTY, IOWA — SHEET NUMBER 34

35

N

2 080 000 FEET

R. 20 W.

(Joins sheet 27)

(Joins sheet 36)

T. 80 N. (Joins sheet 34)

1 Mile

5 000 Feet

Scale 1:15 840

1 095 000 FEET

(Joins sheet 43)

JASPER COUNTY, IOWA — SHEET NUMBER 36

36

N

R. 20 W. | R. 19 W.

(Joins sheet 28)

(Joins sheet 35)

(Joins sheet 37)

(Joins sheet 44)

T. 80 N.

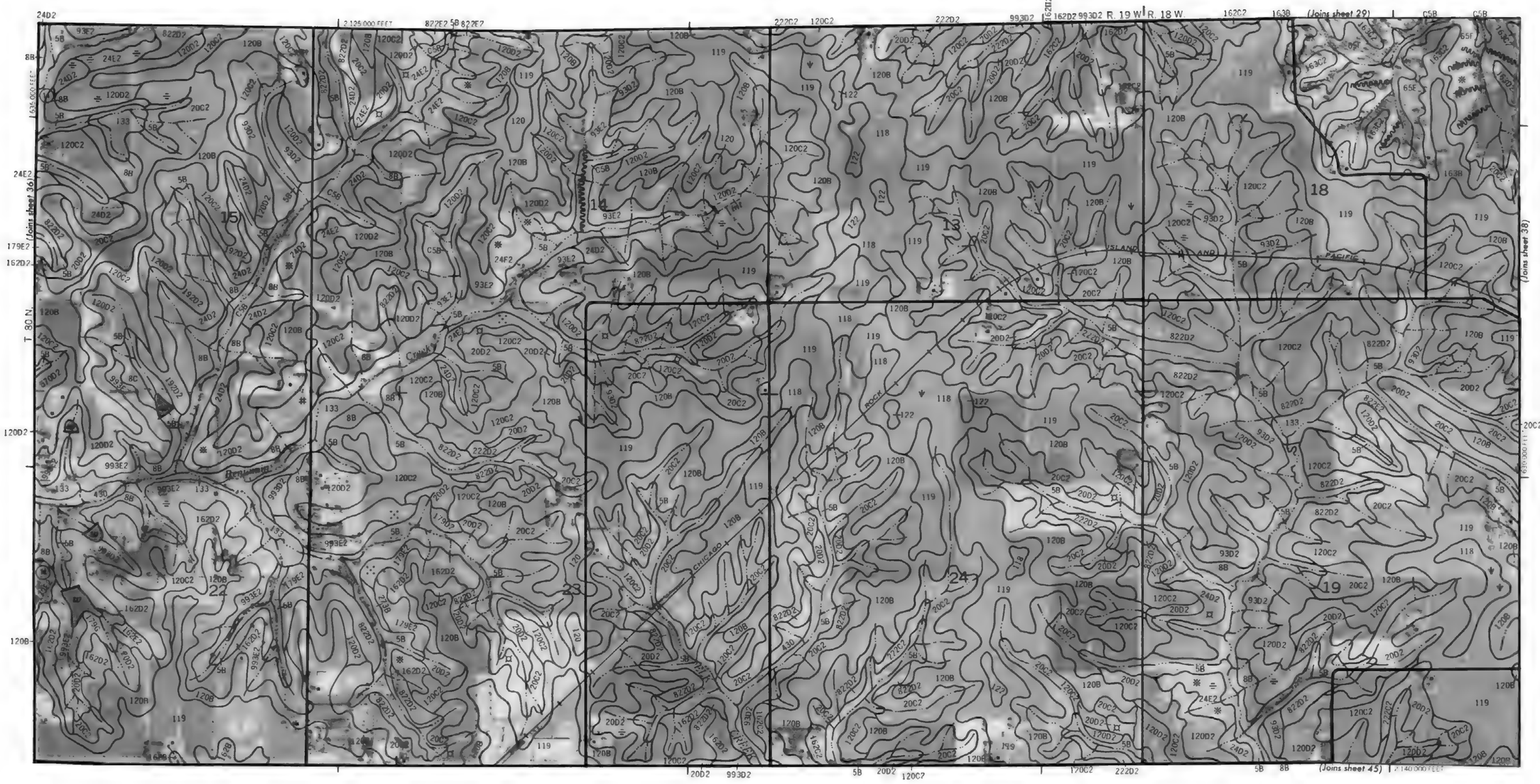
Benjamin

1 Mile

5 000 Feet

Scale 1:15 840

JASPER COUNTY, IOWA — SHEET NUMBER 37



37

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

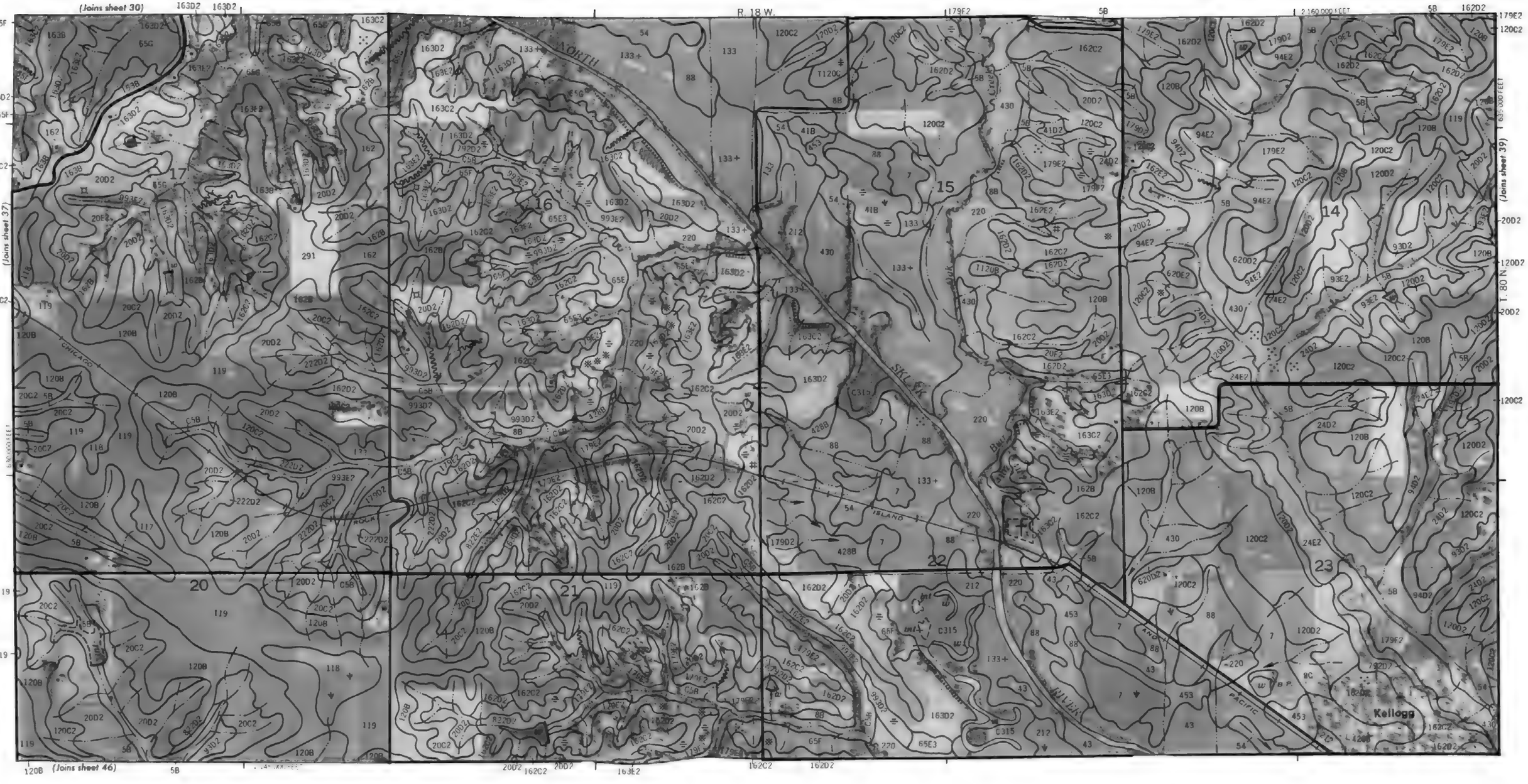
38

N

1 Mile 5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1 000 2 000 3 000 4 000 5 000



39

N

R. 18 W. | R. 17 W.

T. 80 N

ROCK CREEK LAKE

STATE PARK

MADE LAND

CREEK

BORROW PIT

BOOM

Rock Creek

Water

(Joins sheet 38)

(Joins sheet 40)

(Joins sheet 31)

(Joins sheet 47)

2 165 000 FEET

2 180 000 FEET

635 000 FEET

1 Mile

5 000 Feet

Scale 1:15 840

JASPER COUNTY, IOWA — SHEET NUMBER 40

40

N

1 Mile

5 000 Feet

Scale 1:15 840

R 17 W.

T 80 N.

(Joins sheet 32)

(Joins sheet 39)

(Joins sheet 48)

2 205 000 FEET

2 185 000 FEET

1 635 000 FEET

POWESHIEK COUNTY

Sugar Creek

Water

15

14

13

22

23

24

41
N
2 040 000 FEET
R. 21 W.
(Joins sheet 33)
625 000 FEET
T. 80 N.
COUNTY
SOUTH
SKUNK
RIVER
30
29
28
31
32
33
Oswalt
(Joins sheet 49)
2 055 000 FEET
(Joins sheet 42)
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000

(42)

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 34)

(Joins sheet 41)

(Joins sheet 50)

(Joins sheet 43)

R. 21 W. | R. 20 W.

T. 80 N.

2 075 000 FEET

2 060 000 FEET

625 000 FEET

27

26

25

30

35

36

31

34

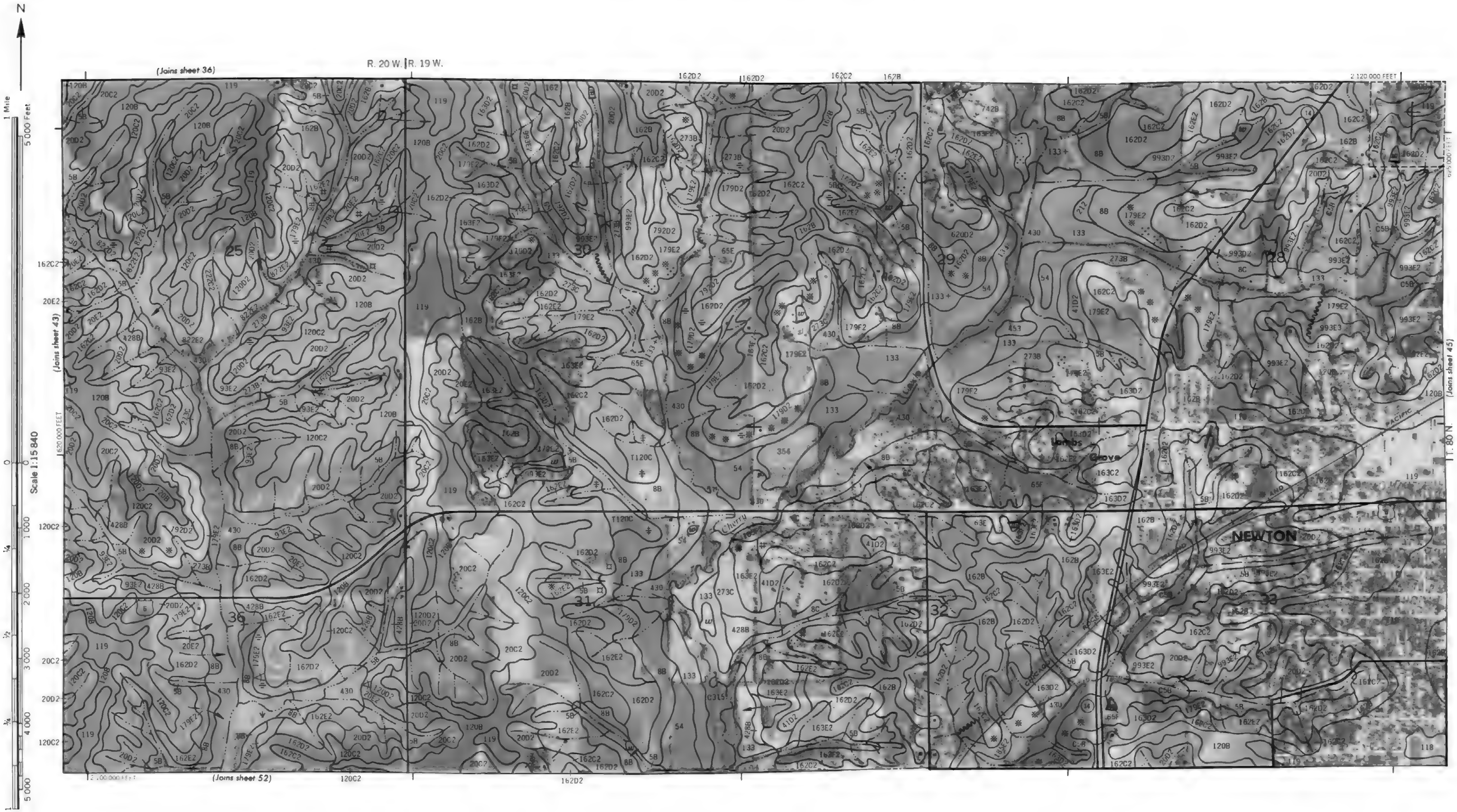
water

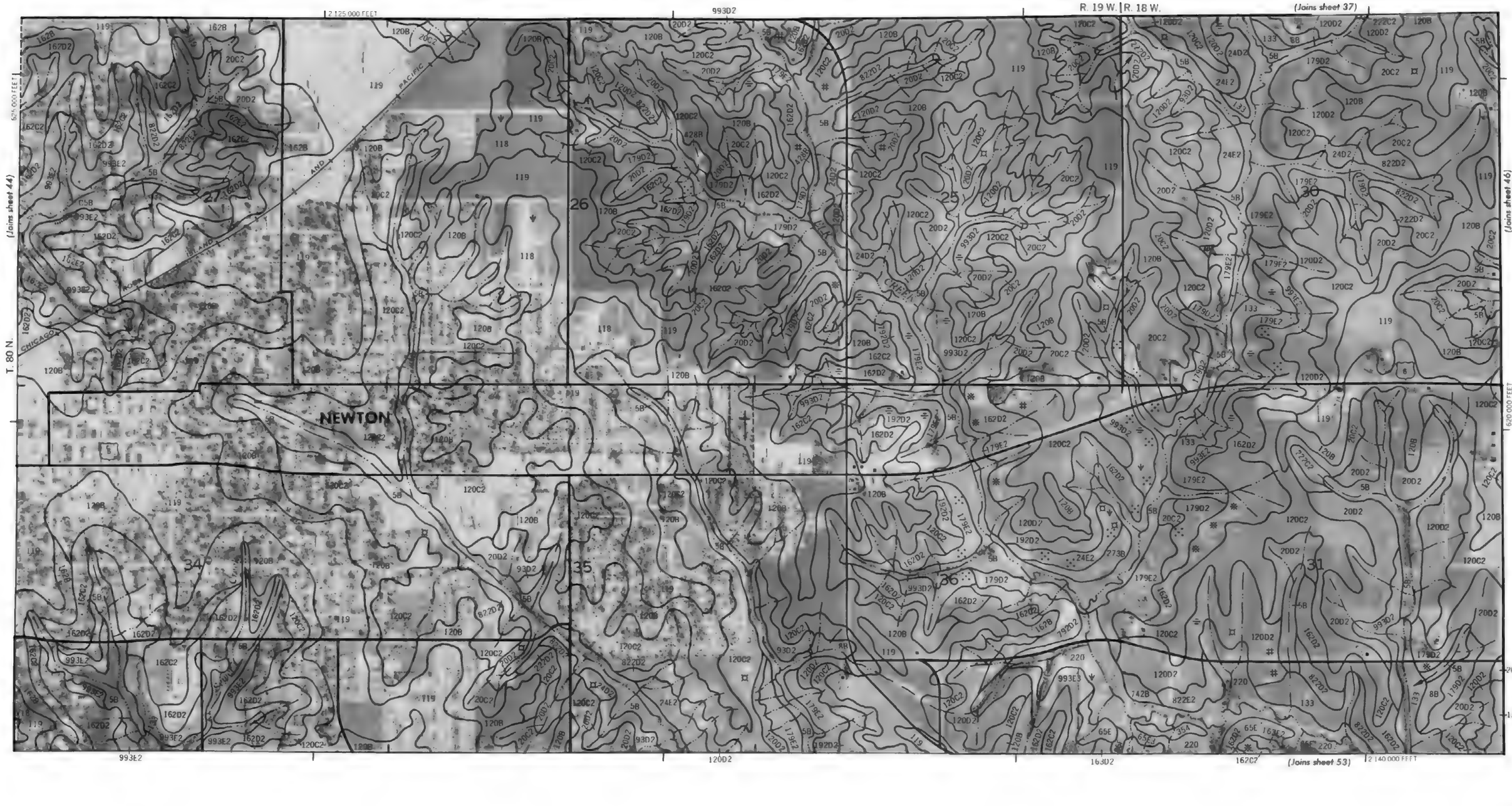
GRAVEL PIT

SOUTH SKUNK RIVER


N
R. 20 W
T. 80 N.
(Joins sheet 42)
(Joins sheet 35)
(Joins sheet 44)
(Joins sheet 51)
2 095 000 FEET
620 000 FEET
Goddard
INDIANA
SOUTH
BORROW PIT
Prairie
water
29
28
27
26
33
32
34
35
1 Mile
5 000 Feet
Scale 1:15 840

JASPER COUNTY, IOWA — SHEET NUMBER 44




2 125 000 FEET
R. 19 W.
R. 18 W.
(Joins sheet 37)
T. 80 N.
(Joins sheet 44)
(Joins sheet 46)
(Joins sheet 53)
2 140 000 FEET
620 000 FEET
NEWTON
CHICAGO
PACIFIC
AND
ISLAND
CREEK
26
25
30
34
35
36
31
N
1 Mile
5 000 Feet
Scale 1:15 840

46

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 38)

R. 18 W.

2 160 000 FEET

620 000 FEET

625 000 FEET

T. 80 N.

(Joins sheet 45)

(Joins sheet 47)

(Joins sheet 54)

2 145 000 FEET

Kellogg

SKUNK RIVER

North Skunk Creek

29

28

27

26

32

33

34

35

(47)

N

R. 18 W. | R. 17 W.

T. 80 N.

2 165 000 FEET

675 000 FEET

(Joins sheet 46)

(Joins sheet 39)

(Joins sheet 48)

(Joins sheet 55)

2 180 000 FEET

670 000 FEET

1 Mile

5 000 Feet

Scale 1:15 840

Kellogg

Bear Creek

CHICAGO, ROCK ISLAND AND PACIFIC RAILROAD

NORTH SKUNK RIVER

SOUTH SKUNK RIVER

KELLOGG GAME AREA BOUNDARY

BORROW PIT

water

25

30

29

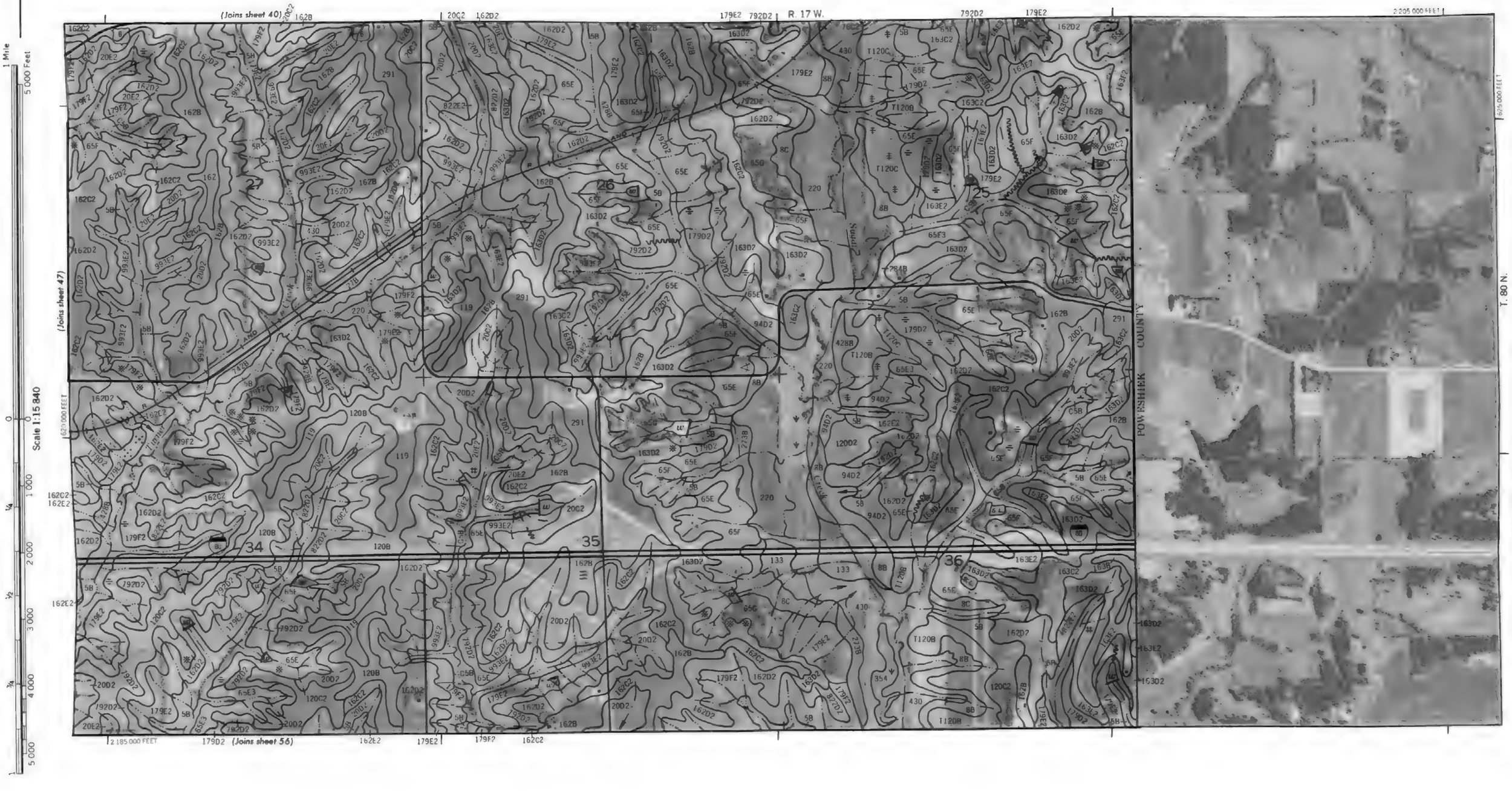
36

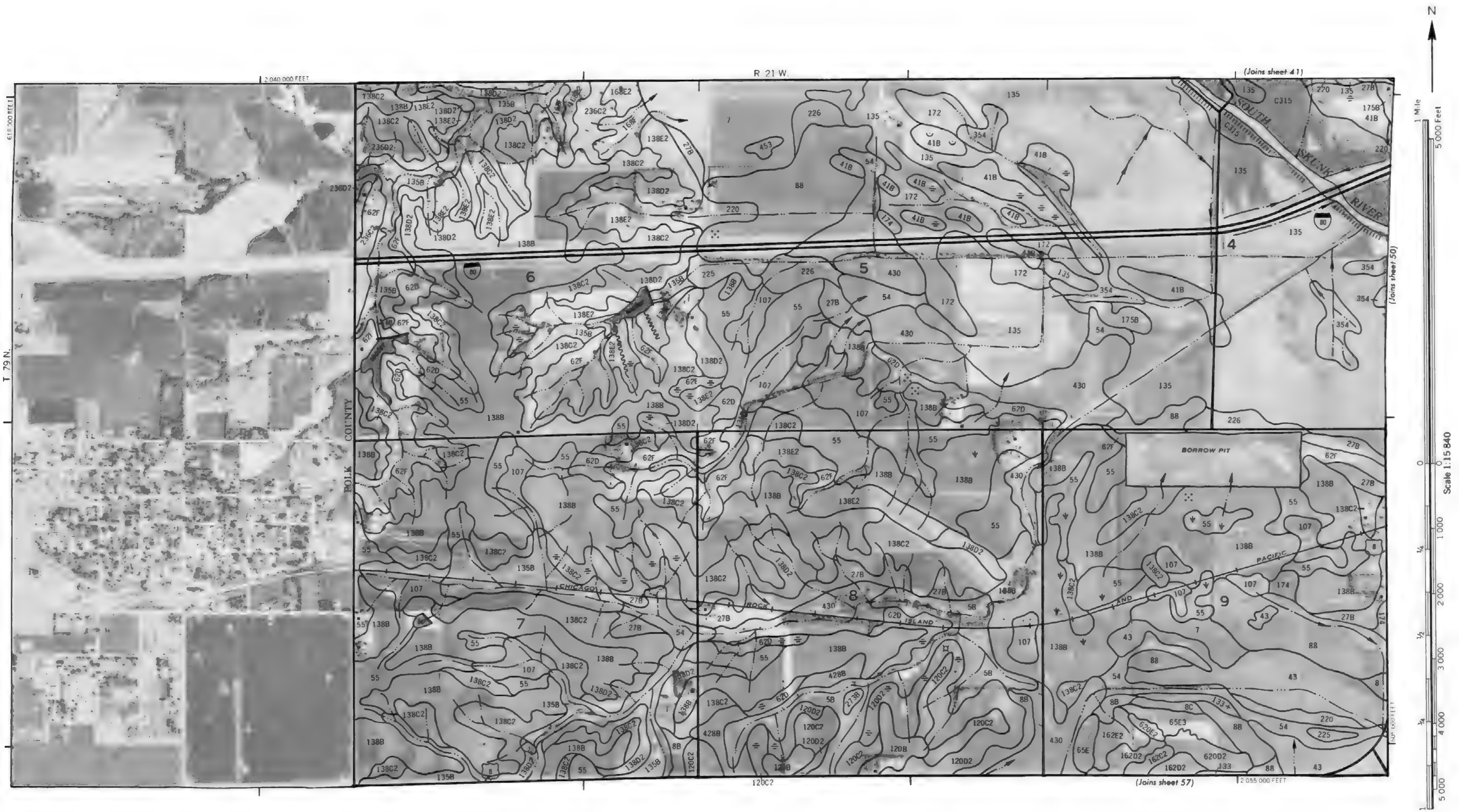
31

32

33

JASPER COUNTY, IOWA — SHEET NUMBER 48




N
R 21 W.
(Joins sheet 41)
(Joins sheet 50)
(Joins sheet 57)
2 040 000 FEET
2 055 000 FEET
T 79 N.
POLK COUNTY
SOUTH SKUNK RIVER
BORROW PIT
CHICAGO ROCK ISLAND AND PACIFIC
80
4
5
6
7
8
9
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 42)
(Joins sheet 49)
(Joins sheet 51)
(Joins sheet 58)
R. 21 W. | R. 20 W.
T. 79 N.
water
GRAVEL PIT
SOUTH
SKUNK
RIVER
CHICAGO
ROCK
ISLAND
PACIFIC
Colfax
Sugar Creek
Squaw Creek


51
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
¼
2 000
½
3 000
¾
4 000
1
5 000
2 080 000 FEET
2 095 000 FEET
615 000 FEET
R. 20 W.
T. 79 N.
(Joins sheet 43)
(Joins sheet 50)
(Joins sheet 52)
(Joins sheet 59)
SOUTH Skunk River
SKUNK River
CHICAGO, ROCK ISLAND & PACIFIC
Metz
Sevens Creek
5
4
3
2
8
9
10
11

JASPER COUNTY, IOWA — SHEET NUMBER 52

(52)

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 44)

R. 20 W.

R. 19 W.

2 120 000 FEET

615 000 FEET

(Joins sheet 51)

(Joins sheet 53)

T. 79 N.

2 100 000 FEET

(Joins sheet 60)

REFUSE DUMP

SEWAGE LAGOON

CHICAGO, ROCK ISLAND & PACIFIC R.R.

Creek

Skunk River

53

N

2 125 000 FEET

R. 19 W. | R. 18 W.

(Joins sheet 52)

(Joins sheet 54)

(Joins sheet 61)

2 140 000 FEET

T. 79 N.

NEWTON MUNICIPAL AIRPORT

SEWAGE TREATMENT PLANT

BORROW PIT

Creek

Clark

Scale 1:15 840

1 Mile

5 000 Feet

JASPER COUNTY, IOWA — SHEET NUMBER 54

54

N

1 Mile

5 000 Feet

Scale 1:15 840

R 18 W

T. 79 N.

(Joins sheet 53)

(Joins sheet 46)

(Joins sheet 55)

(Joins sheet 62)

Creek

JASPER COUNTY, IOWA — SHEET NUMBER 55

56

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 17 W

T. 79 N

(Joins sheet 48)

(Joins sheet 55)

(Joins sheet 57)

(Joins sheet 64)

2 209 000 FEET

2 185 000 FEET

615 000 FEET

610 000 FEET

POWESHIEK COUNTY

Sugar Creek

10

11

12

N

2 040 000 FEET

R. 21 W.

(Joins sheet 49)

T. 79 N.

600 000 FEET

POLK COUNTY

CHICAGO ROCK ISLAND AND PACIFIC

(Joins sheet 58)

(Joins sheet 65)

2 055 000 FEET

595 000 FEET

1 Mile

5 000 Feet

Scale 1:15 840

JASPER COUNTY, IOWA — SHEET NUMBER 58

58

N

1 Mile

5,000 Feet

Scale 1:15 840

(Joins sheet 50)

(Joins sheet 57)

(Joins sheet 59)

(Joins sheet 66)

R. 21 W

R. 20 W

T 79 N.

2 075 000 FEET

2 060 000 FEET

595 000 FEET

600 000 FEET

15

14

13

18

22

23

24

19

Squaw Creek

STRIP MINE

59

N

R. 20 W.

T. 79 N.

2 080 000 FEET

2 095 000 FEET

(Joins sheet 58)

(Joins sheet 60)

(Joins sheet 51)

(Joins sheet 67)

SALNA RIVER

MINE DUMP

Scale 1:15 840

1 Mile

5 000 Feet

60

N

1 Mile

5 000 Feet

Scale 1:15 840

0 0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

R. 20 W. | R. 19 W.

(Joins sheet 52)

(Joins sheet 59)

(Joins sheet 61)

(Joins sheet 68)

T. 79 N.

SEWAGE LAGOON

SOUTH SKUNK RIVER

Indian Creek

Cherry Creek

13 18 17 16 24 19 20 21

2 100 000 FEET

1 595 000 FEET

N

R. 19 W. | R. 18 W.

T. 79 N.

(Joins sheet 60)

(Joins sheet 53)

(Joins sheet 62)

(Joins sheet 69)

2 125 000 FEET

2 140 000 FEET

620 000 FEET

Carson Creek

1 Mile

5 000 Feet

Scale 1:15 840

62

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

(Joins sheet 54)

822D2 120D2 179D2 R. 18 W. 93D2 822D2 822D2

2 160 000 FEET

635 000 FEET

(Joins sheet 61)

(Joins sheet 63)

T. 79 N.

16 15 14

20 21 22 23

133+

(Joins sheet 70)

2 145 000 FEET


R 18 W.
R 17 W.
T 79 N.
(Joins sheet 62)
(Joins sheet 55)
(Joins sheet 64)
(Joins sheet 71)
595 000 FEET
2 180 000 FEET
13
18
17
16
24
19
20
21
Slater Creek
SKUNK RIVER
GRAVEL PIT
QUARRY
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1/4
1/2
3/4
1
1 000
2 000
3 000
4 000
5 000

JASPER COUNTY, IOWA — SHEET NUMBER 64

64

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

(Joins sheet 56)

R. 17 W.

2 205 000 FEET

2 185 000 FEET

(Joins sheet 63)

(Joins sheet 72)

T. 79 N.

SKUNK RIVER

SQUAW CREEK

QUARRY

15

14

13

22

23

24

65

N

R. 21 W.

(Joins sheet 57)

T. 79 N.

COUNTY

POLK

POLK COUNTY

(Joins sheet 66)

(Joins sheet 73)

30 29 28

31 32 33

Creek

1 Mile

5 000 Feet

Scale 1:15 840

66

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

1 000 2 000 3 000 4 000 5 000

(Joins sheet 58)

(Joins sheet 65)

(Joins sheet 67)

R. 21 W. R. 20 W.

T. 79 N

2 075 000 FEET

2 060 000 FEET

(Joins sheet 73)

(Joins sheet 74)

CHICAGO, ROCK ISLAND & PACIFIC

Squaw Creek

PRAIRIE CITY

26 27 25 30 34 35 36 31

N

R. 20 W.

T 79 N.

(Joins sheet 66)

(Joins sheet 59)

(Joins sheet 68)

(Joins sheet 74)

(Joins sheet 75)

2 080 000 FEET

2 085 000 FEET

2 090 000 FEET

2 095 000 FEET

585 000 FEET

Grove

Creek

Warren

1 Mile

5 000 Feet

Scale 1:15 840

0 1 000 2 000 3 000 4 000 5 000

68

N

1 Mile

5,000 Feet

Scale 1:15 840

0 1/4 1/2 3/4 1

1 000 2 000 3 000 4 000 5 000

R. 20 W | R. 19 W

(Joins sheet 60)

(Joins sheet 67)

(Joins sheet 69)

T. 79 N

25 30 29 28 36 31 32 33

SOUTH SKUNK RIVER

Creek Sewer

BORROW PIT

(Joins sheet 75) (Joins sheet 76)

N

R. 19 W. | R. 18 W.

T. 79 N.

(Joins sheet 68)

(Joins sheet 61)

(Joins sheet 70)

(Joins sheet 76) | (Joins sheet 77)

2 125 000 FEET

2 140 000 FEET

1 Mile

5 000 Feet

Scale 1:15 840

70

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 62)

R. 18 W.

T. 79 N.

(Joins sheet 69)

(Joins sheet 71)

(Joins sheet 77)

(Joins sheet 78)

2 160 000 FEET

2 145 000 FEET

585 000 FEET

N

R. 18 W. | R. 17 W.

T. 79 N.

(Joins sheet 70)

(Joins sheet 72)

(Joins sheet 63)

(Joins sheet 78) | (Joins sheet 79)

Creek

Scale 1:15 840

1 Mile

5 000 Feet

JASPER COUNTY, IOWA — SHEET NUMBER 72

72

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 17 W.

T. 79 N.

(Joins sheet 64)

(Joins sheet 71)

(Joins sheet 79)

(Joins sheet 80)

2 205 000 FEET

2 185 000 FEET

490 000 FEET

485 000 FEET

NORTH SKUNK RIVER

POWESHIEK COUNTY

27 26 25 34 35 36


2 045 000 FEET
R. 21 W.
(Joins sheet 65)
(Joins sheet 66)
(Joins sheet 74)
(Joins sheet 81)
2 060 000 FEET
T. 78 N.
580 000 FEET
POLK COUNTY
N
1 Mile
5 000 Feet
Scale 1:15 840

74

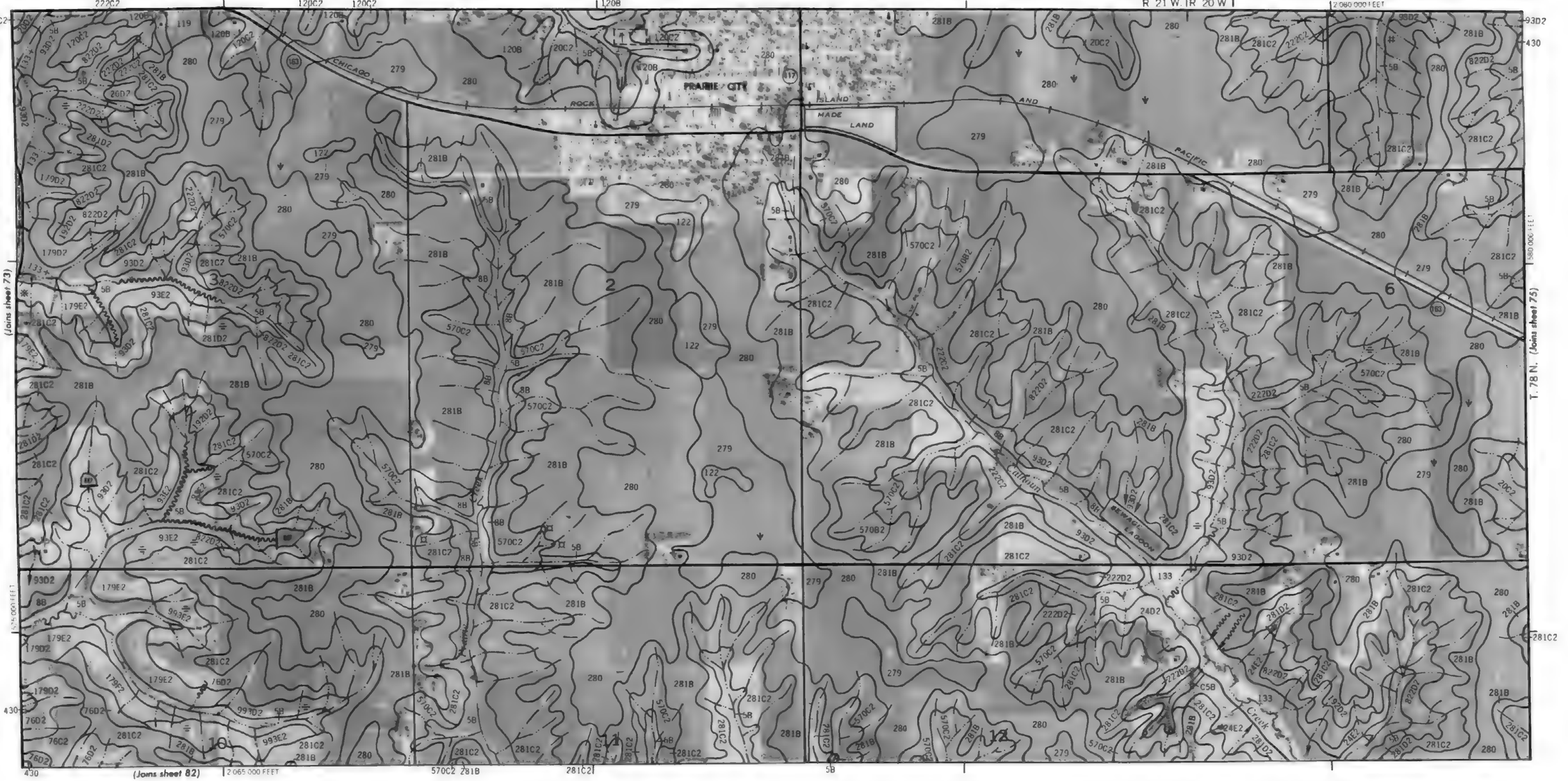
N

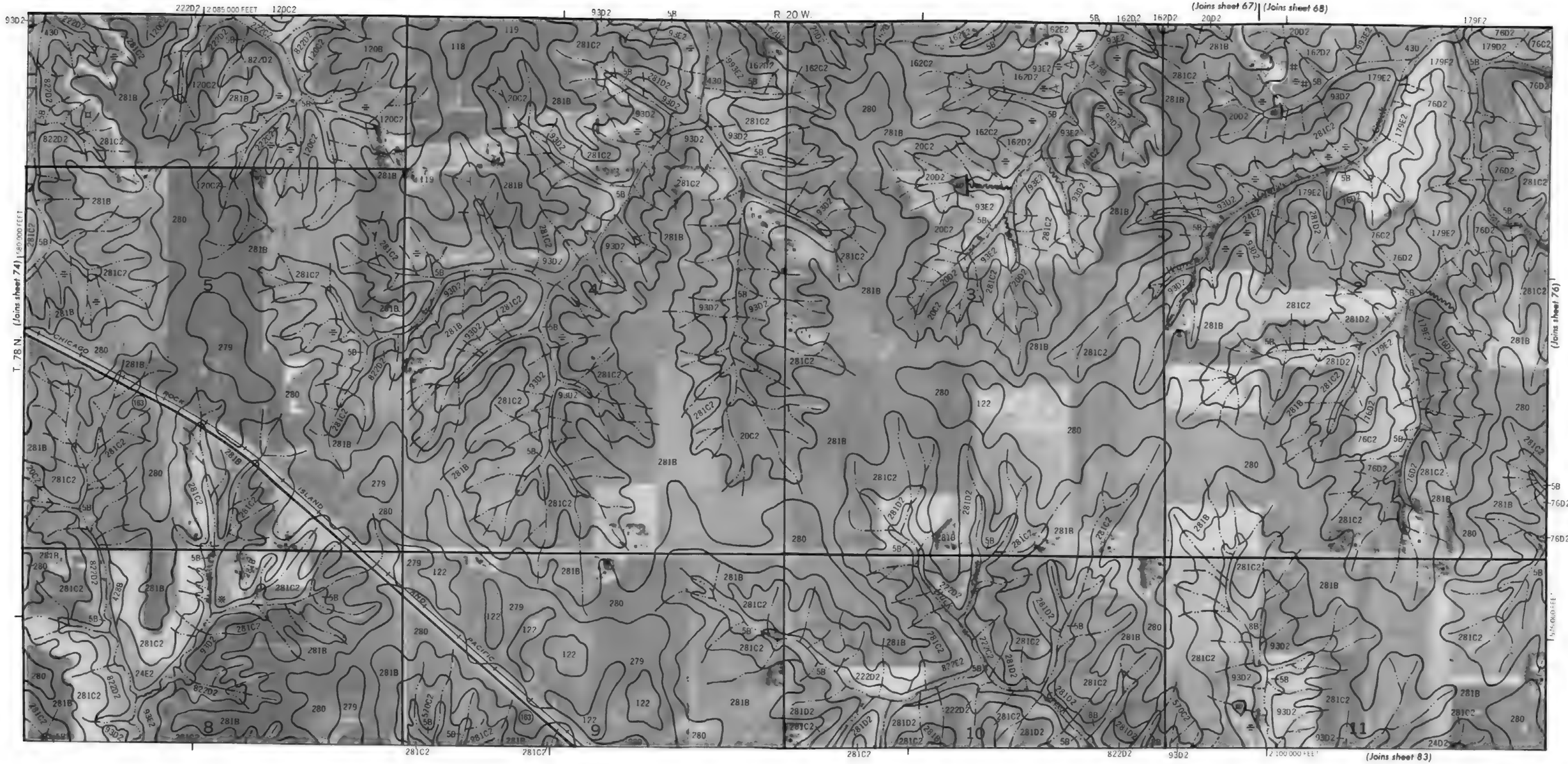
1 Mile

5 000 Feet

Scale 1:15 840

0 1 000 2 000 3 000 4 000 5 000





75

N

1 Mile

5 000 Feet

Scale 1:15 840

0 1 000 2 000 3 000 4 000 5 000

JASPER COUNTY, IOWA — SHEET NUMBER 76

77

N

R. 19 W. | R. 18 W.

2 125 000 FEET

(Joins sheet 69) | (Joins sheet 70)

(Joins sheet 76)

T. 78 N

530 000 FEET

Reasnor

Creek

GRAVEL PIT

water

(Joins sheet 78)

(Joins sheet 85)

2 145 000 FEET

530 000 FEET

1 Mile

5 000 Feet

Scale 1:15 840

JASPER COUNTY, IOWA — SHEET NUMBER 78


R. 18 W
R. 17 W.
T. 78 N
(Joins sheet 78)
(Joins sheet 71)
(Joins sheet 72)
(Joins sheet 80)
(Joins sheet 87)
2 170 000 FEET
2 185 000 FEET
SEWAGE LAGOON
Creek
Int
Little
Sulf
N
1 Mile
5 000 Feet
Scale 1:15 840
0
1 000
2 000
3 000
4 000
5 000

JASPER COUNTY, IOWA — SHEET NUMBER 80

80

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 72)

R. 17 W.

POWESHIEK COUNTY

2 205 000 FEET

T. 78 N.

580 000 FEET

(Joins sheet 79)

(Joins sheet 88)

2 190 000 FEET

NORTH SKUNK RIVER

Lynnville

GRAVEL PIT

SEWAGE LAGOON

Creek

N

2 045 000 FEET

R 21 W

(Joins sheet 73)

T 78 N.

POLK COUNTY

(Joins sheet 82)

(Joins sheet 89)

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1 000 2 000 3 000 4 000 5 000

JASPER COUNTY, IOWA — SHEET NUMBER 82

82

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 21 W. | R. 20 W.

T. 78 N.

(Joins sheet 74)

(Joins sheet 81)

(Joins sheet 83)

(Joins sheet 90)

2 080 000 FEET

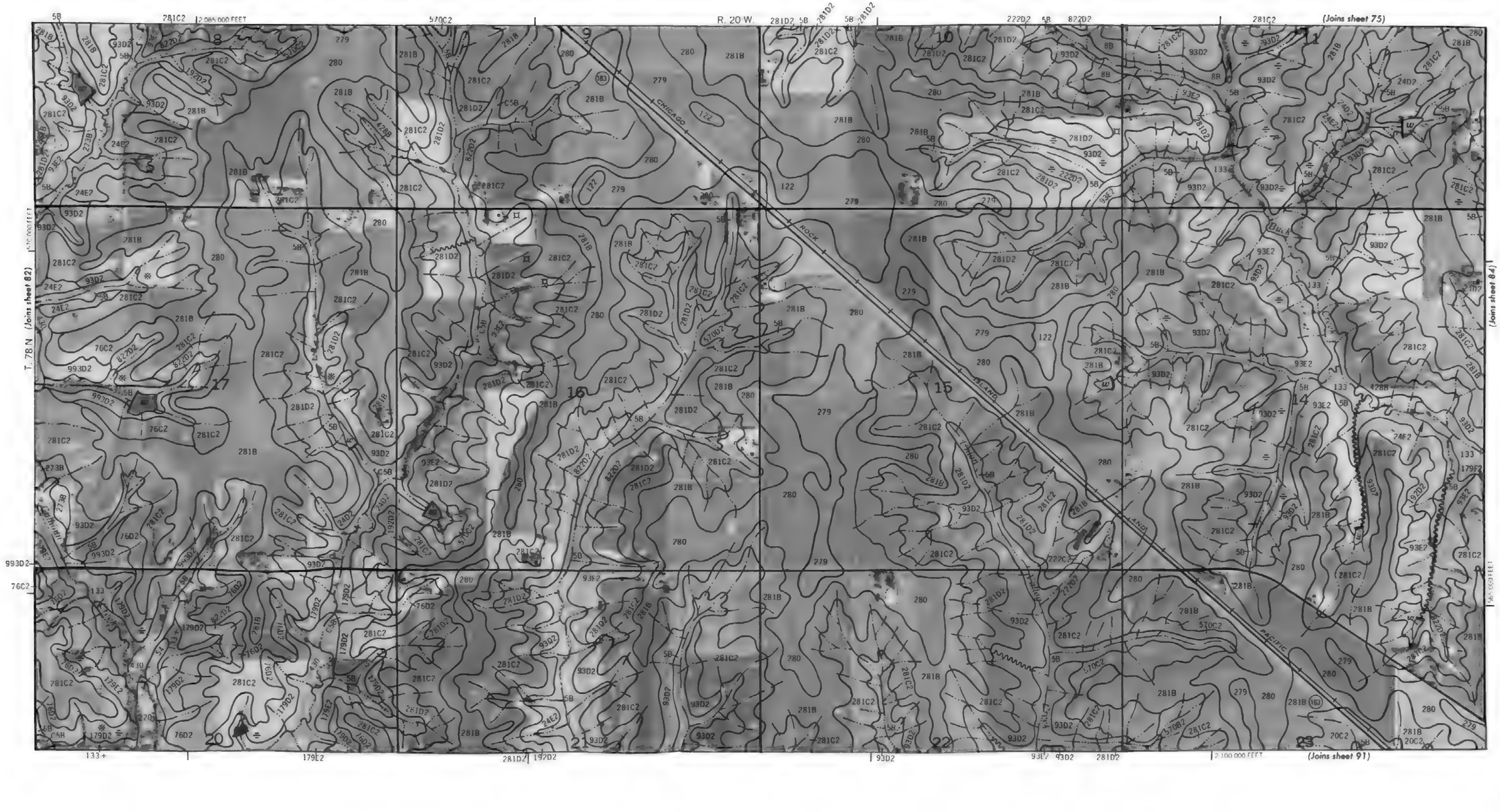
2 070 000 FEET

2 065 000 FEET

Prairie Creek

Calhoun Creek

JASPER COUNTY, IOWA — SHEET NUMBER 83



84

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 76) R. 20 W. | R. 19 W.

(Joins sheet 83)

(Joins sheet 85) T. 78 N.

2 120 000 FEET

2 105 000 FEET

(Joins sheet 92)

Buck

N

R. 19 W. | R. 18 W.

T. 78 N.

(Joins sheet 84)

(Joins sheet 77)

(Joins sheet 86)

(Joins sheet 93)

2 125 000 FEET

2 145 000 FEET

1 Mile

5 000 Feet

Scale 1:15 840

0 0 1/4 1 000 1/2 2 000 3/4 3 000 1 4 000 5 000

JASPER COUNTY, IOWA — SHEET NUMBER 86

86

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 18 W.

T. 78 N.

(Joins sheet 85)

(Joins sheet 87)

(Joins sheet 94)

Galesburg

2 165 000 FEET

2 150 000 FEET

N

R. 18 W. | R. 17 W.

T 78 N.

2 170 000 FEET

2 185 000 FEET

(Joins sheet 86)

(Joins sheet 79)

(Joins sheet 88)

(Joins sheet 95)

Buckeye Creek

1 Mile

5 000 Feet

Scale 1:15 840

0 280 1 000 281C2 ¼ 2 000 ½ 3 000 ¾ 4 000 281C2 5B 5 000

JASPER COUNTY, IOWA — SHEET NUMBER 88

88

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 17 W.

T. 78 N.

(Joins sheet 80)

(Joins sheet 87)

(Joins sheet 96)

POWESHIEK COUNTY

RIVER

NORTH SKUNK

10

11

12

13

14

15

22

23

24

2 045 000 FEET

220 | 20C2 | 192D2 76C2 | R 21 W. | 281C2 5B 822D2 (Joins sheet 81) | 281C2 281C2 993D2 5B

N

T 78 N.

1 650 000 FEET

POLK COUNTY

MARION COUNTY

2 060 000 FEET

1 Mile

5 000 Feet

(Joins sheet 90)

Scale 1:15 840

Vandalia

water

Creek

19 20 21 30 29 28 31 32 33

JASPER COUNTY, IOWA — SHEET NUMBER 90

90

N

Scale 1:15 840

1 Mile

5 000 Feet

R. 21 W. | R. 20 W.

T 78 N.

(Joins sheet 82)

(Joins sheet 89)

(Joins sheet 91)

MARION COUNTY

JASPER COUNTY, IOWA — SHEET NUMBER 91

R. 20 W.

T. 78 N.

(Joins sheet 90)

(Joins sheet 83)

(Joins sheet 92)

MARION COUNTY

N

1 Mile

5 000 Feet

Scale 1:15 840

JASPER COUNTY, IOWA — SHEET NUMBER 92

92

N

1 Mile

5 000 Feet

Scale 1:15 840

R. 20 W. | R. 19 W.

(Joins sheet 84)

(Joins sheet 91)

(Joins sheet 93)

T. 78 N.

Buck

MONROE

CHICAGO, ROCK ISLAND AND PACIFIC

STRIP MINE

MARION COUNTY

JASPER COUNTY, IOWA — SHEET NUMBER 93

R. 19 W. R. 18 W.

(Joins sheet 85)

(Joins sheet 92)

(Joins sheet 94)

T. 78 N.

MARION COUNTY

2 125 000 FEET

2 145 000 FEET

1 560 000 FEET

1 550 000 FEET

93

N

1 Mile

5 000 Feet

Scale 1:15 840

JASPER COUNTY, IOWA — SHEET NUMBER 94

94

N

1 Mile

5 000 Feet

Scale 1:15 840

(Joins sheet 86)

(Joins sheet 93)

(Joins sheet 95)

R. 18 W.

T. 78 N.

2 165 000 FEET

560 000 FEET

2 150 000 FEET

550 000 FEET

SOUTH SKUNK RIVER

CREEK

MARION COUNTY

N

R. 18 W. | R. 17 W.

2 170 000 FEET

T. 78 N.

560 000 FEET

(Joins sheet 94)

(Joins sheet 87)

(Joins sheet 96)

555 000 FEET

2 185 000 FEET

Barkley Creek

ELK CREEK

MARION COUNTY

MAHASKA COUNTY

1 Mile

5 000 Feet

Scale 1:15 840

JASPER COUNTY, IOWA — SHEET NUMBER 96

96

N

1 Mile

5 000 Feet

Scale 1:15 840

0 ¼ ½ ¾ 1

0 1 000 2 000 3 000 4 000 5 000

(Joins sheet 88)

(Joins sheet 95)

R. 17 W.

T. 78 N.

555 000 FEET

560 000 FEET

2 190 000 FEET

2 205 000 FEET

Middle Creek

Buck Creek

POWESHIEK COUNTY

MAHASKA COUNTY